CS4221/5421: Tutorial 1 — Entity-Relationship Model

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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.

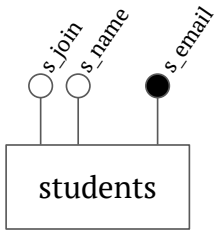
The database also records the date at which a book copy is borrowed and the date at which it is returned. We refer to this information as a loan record. Obviously, a student can only borrow or lend book after he/she is enrolled.

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.

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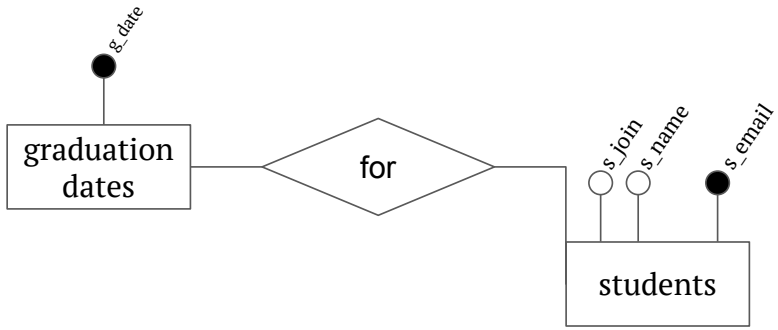

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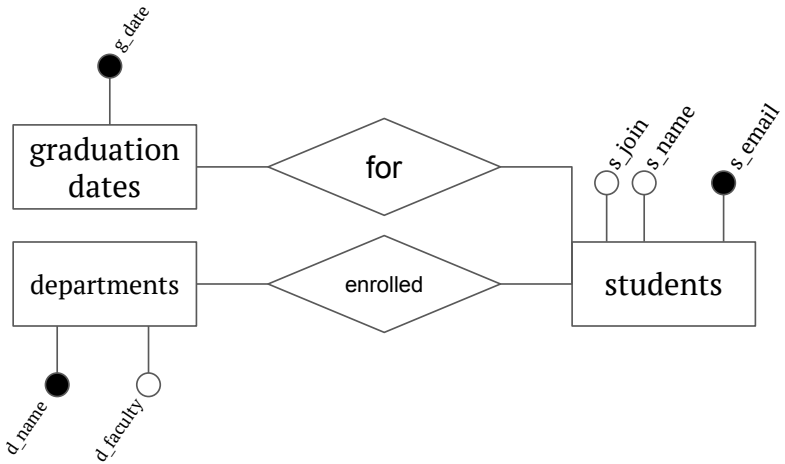

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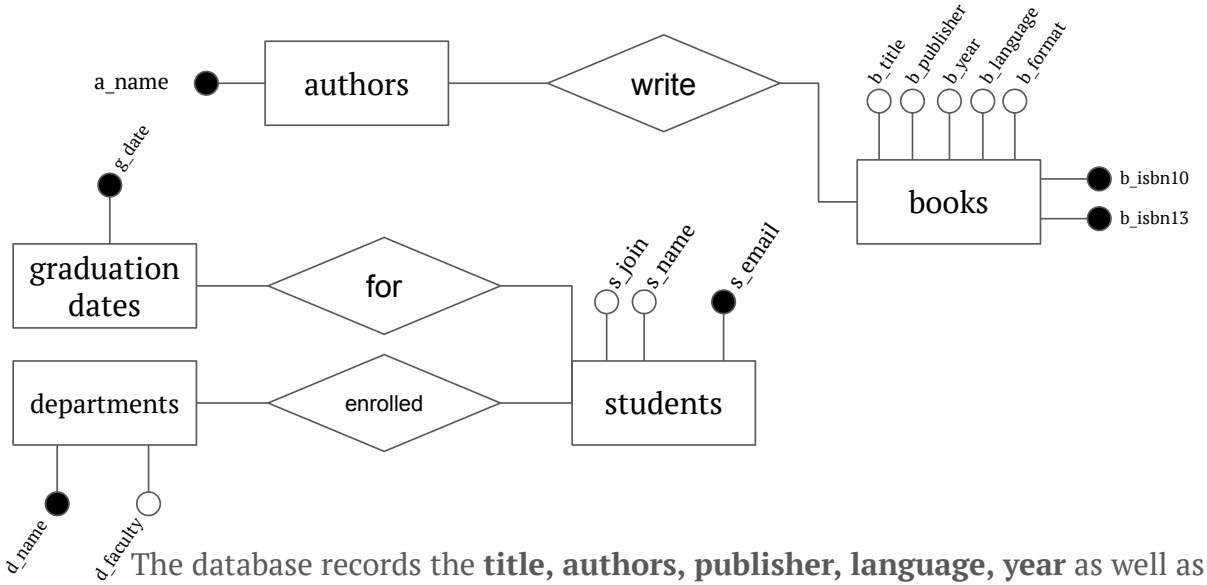

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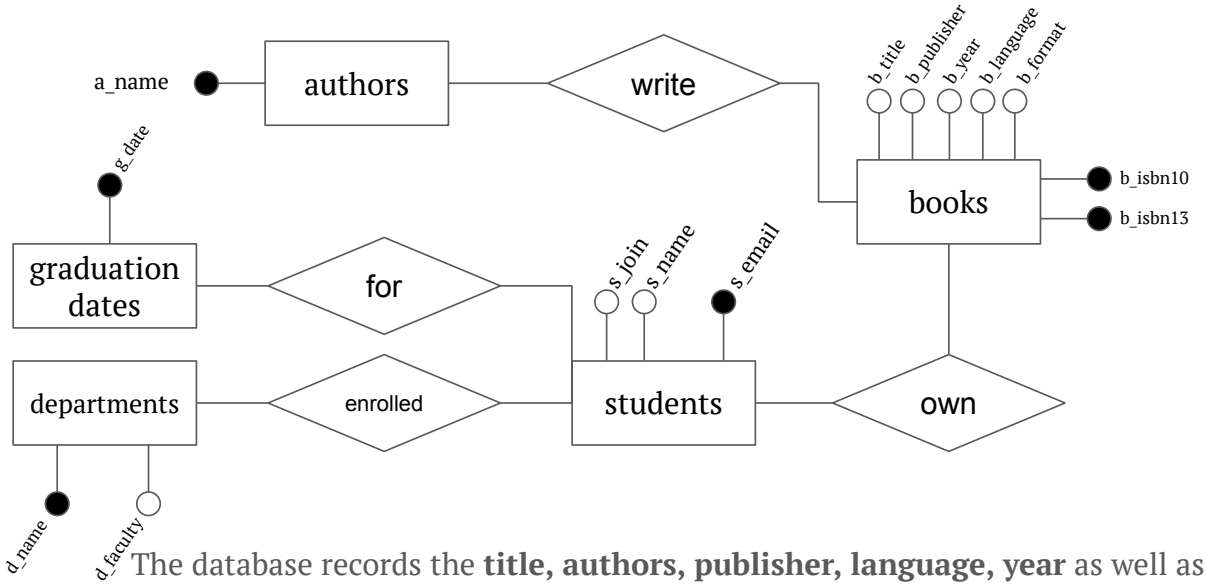

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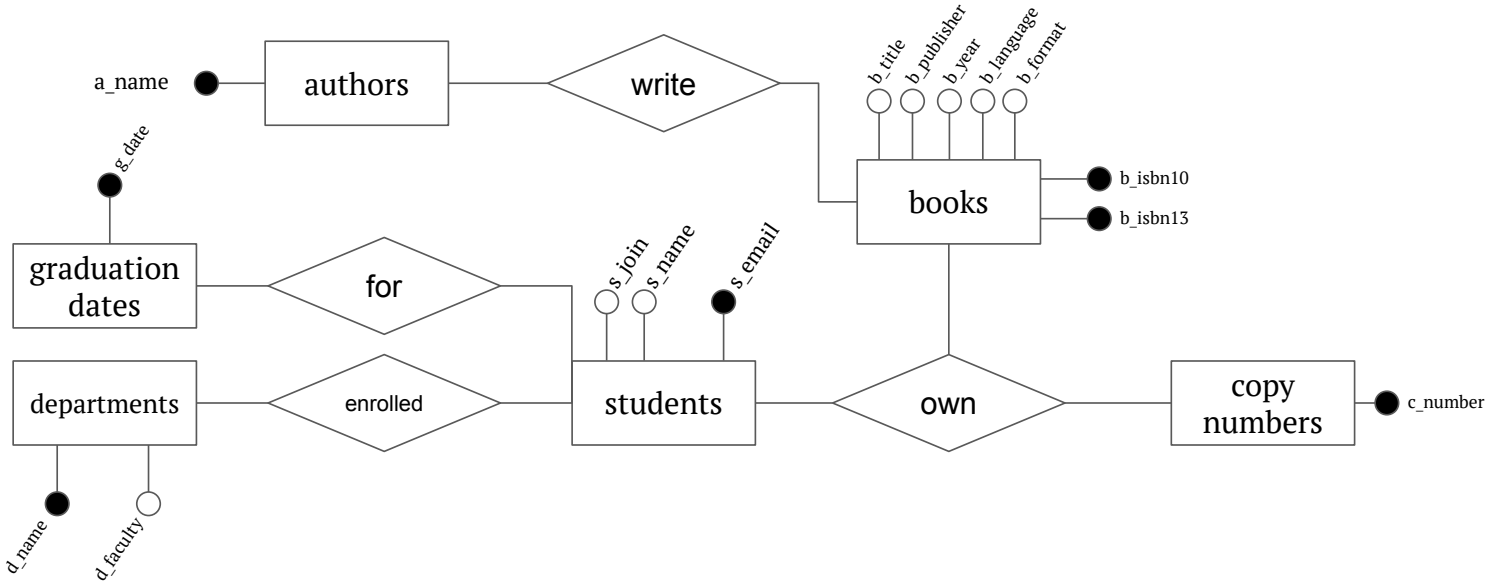

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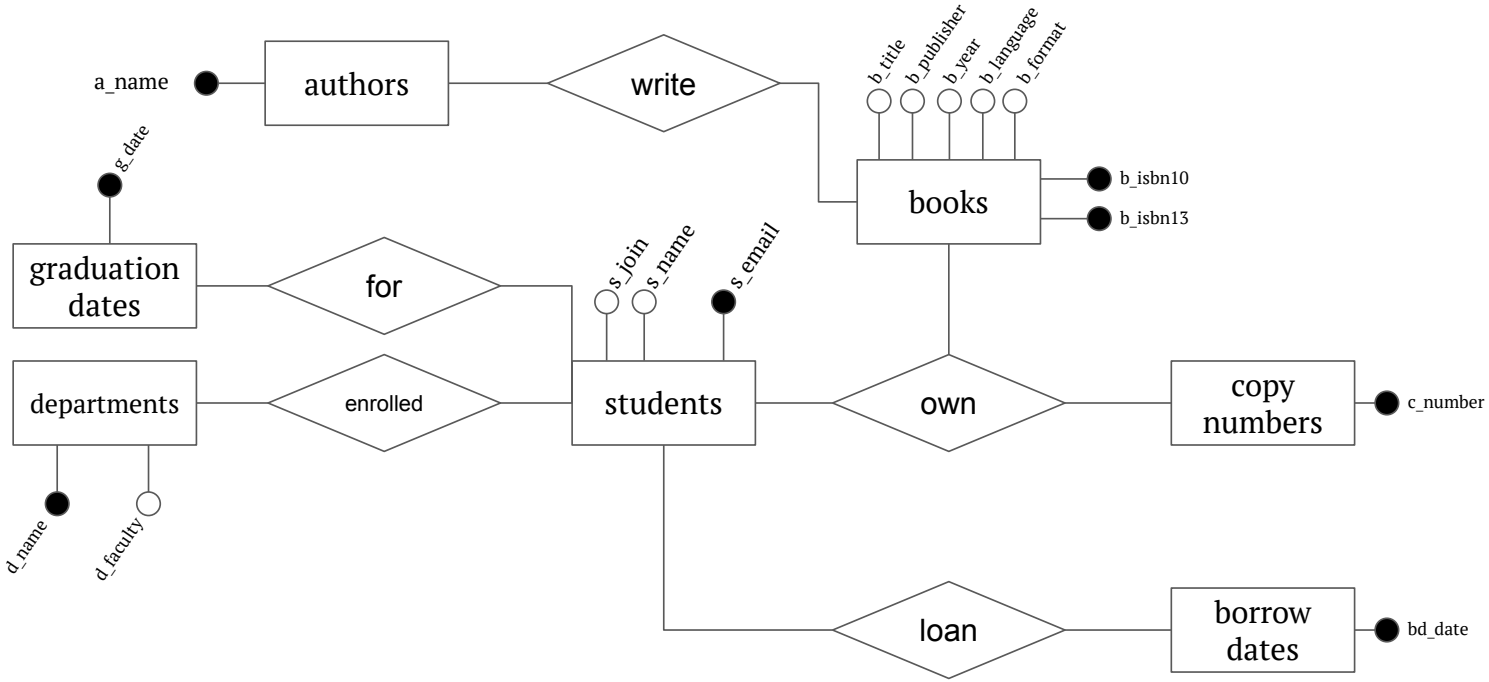

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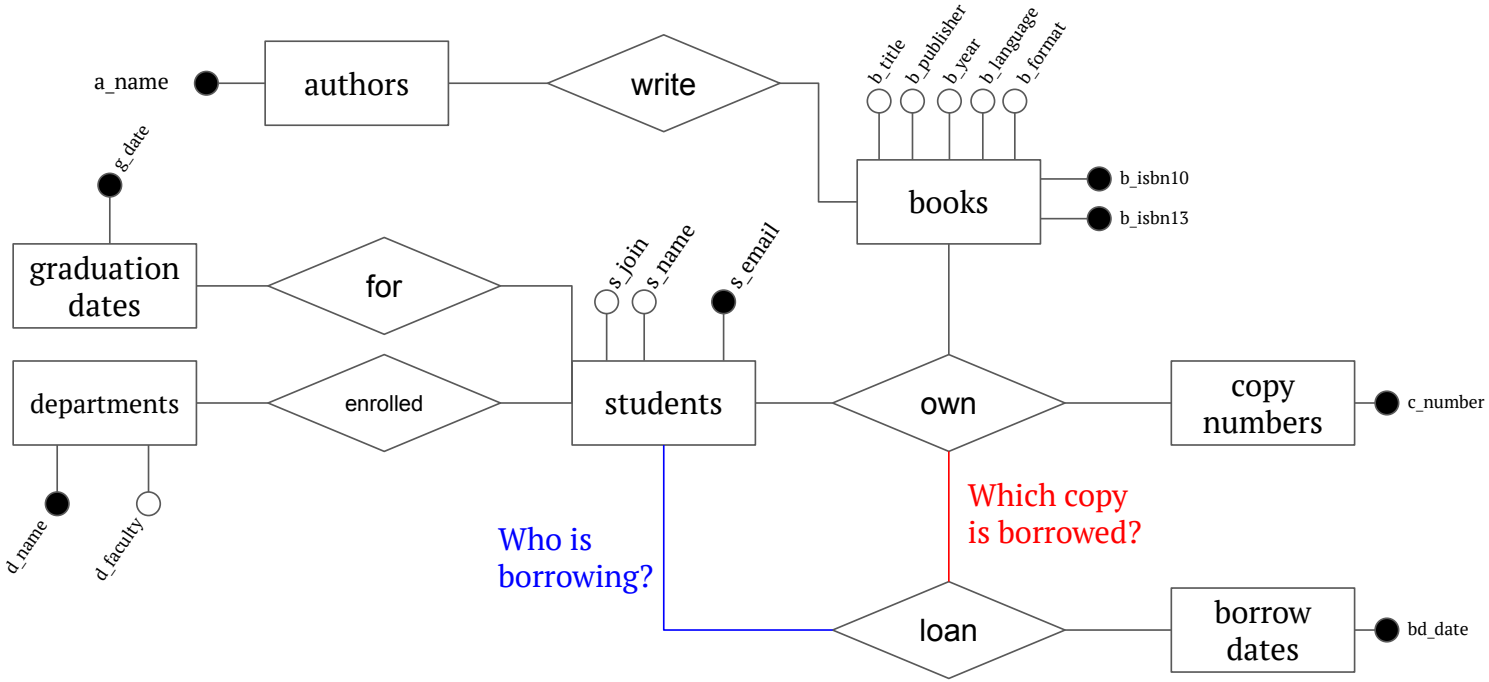

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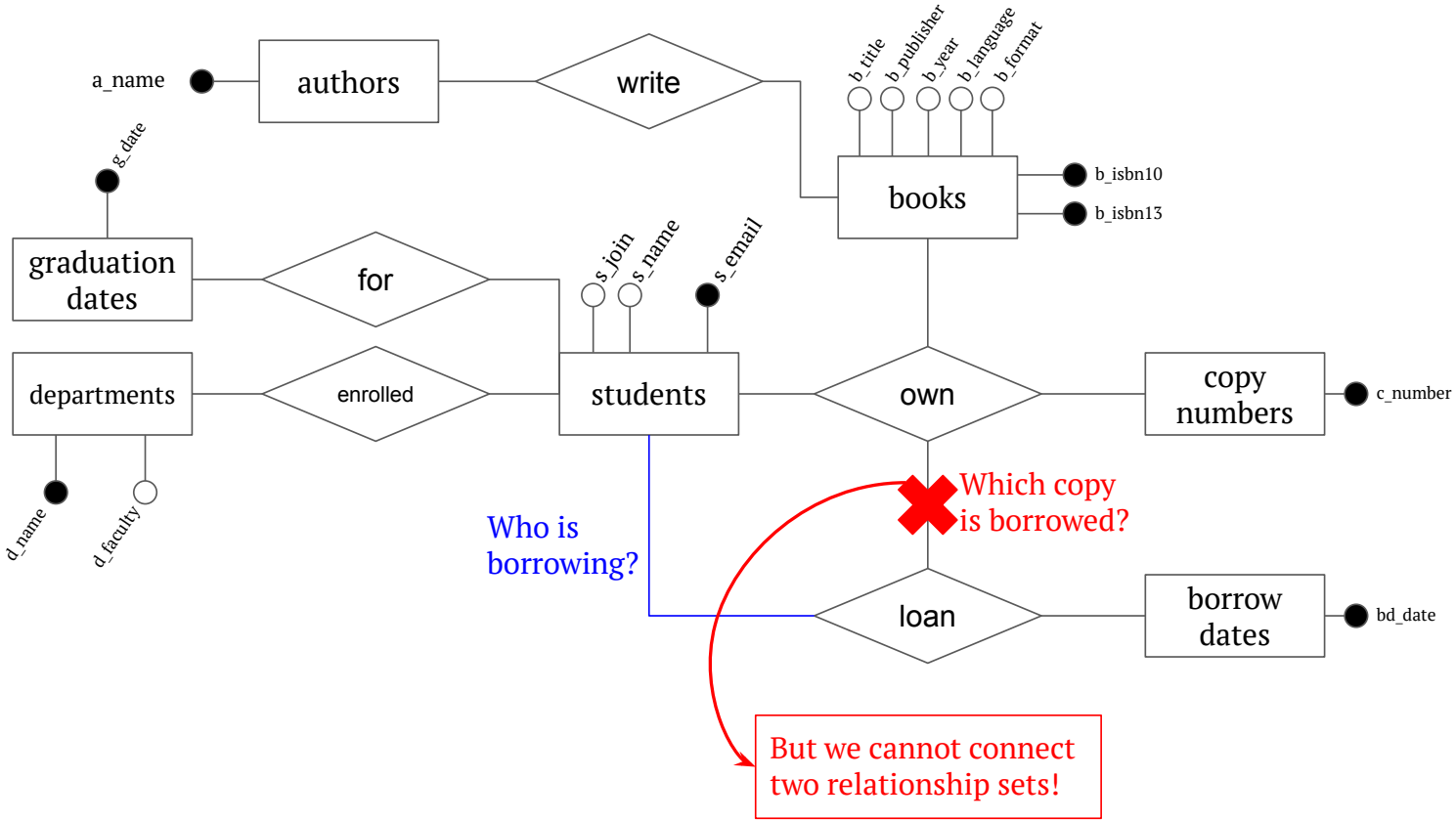

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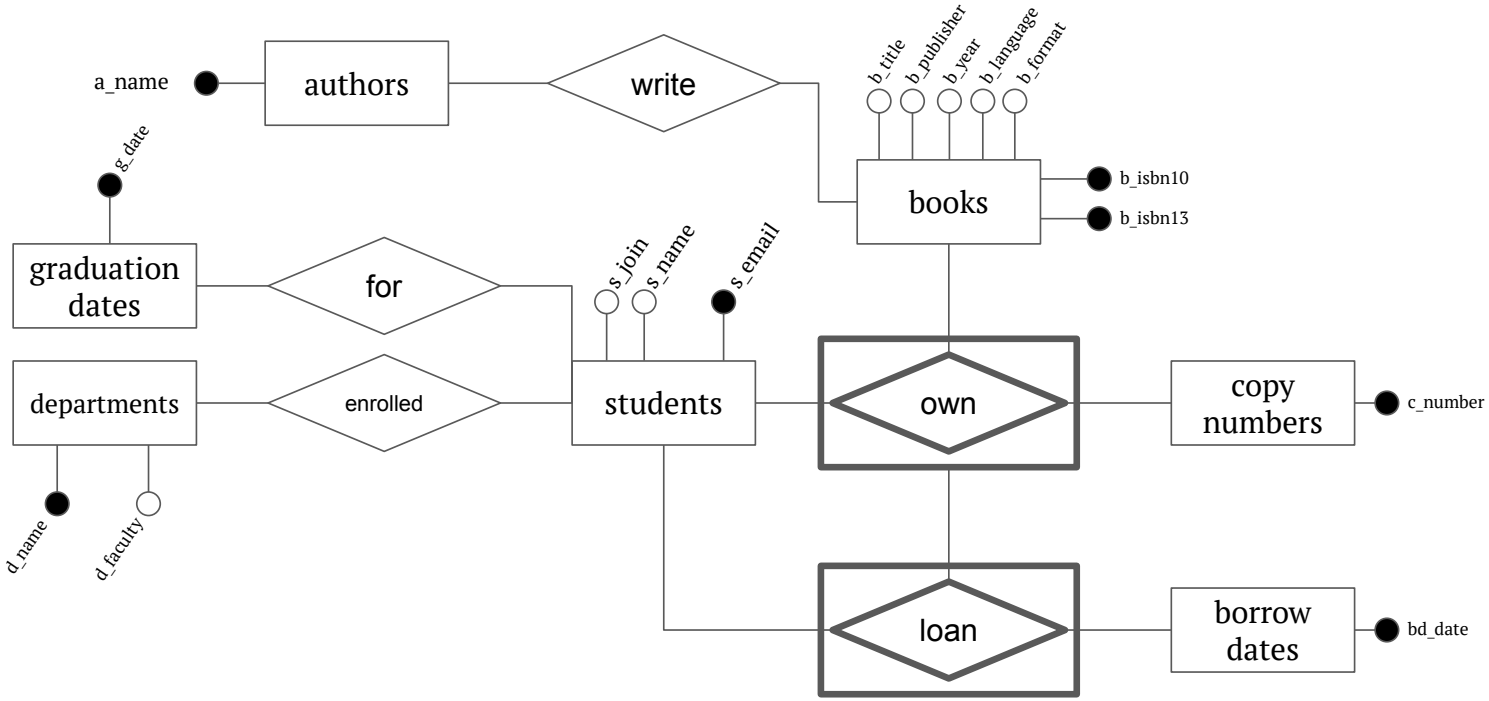

Thus we introduce **"Aggregates"**.

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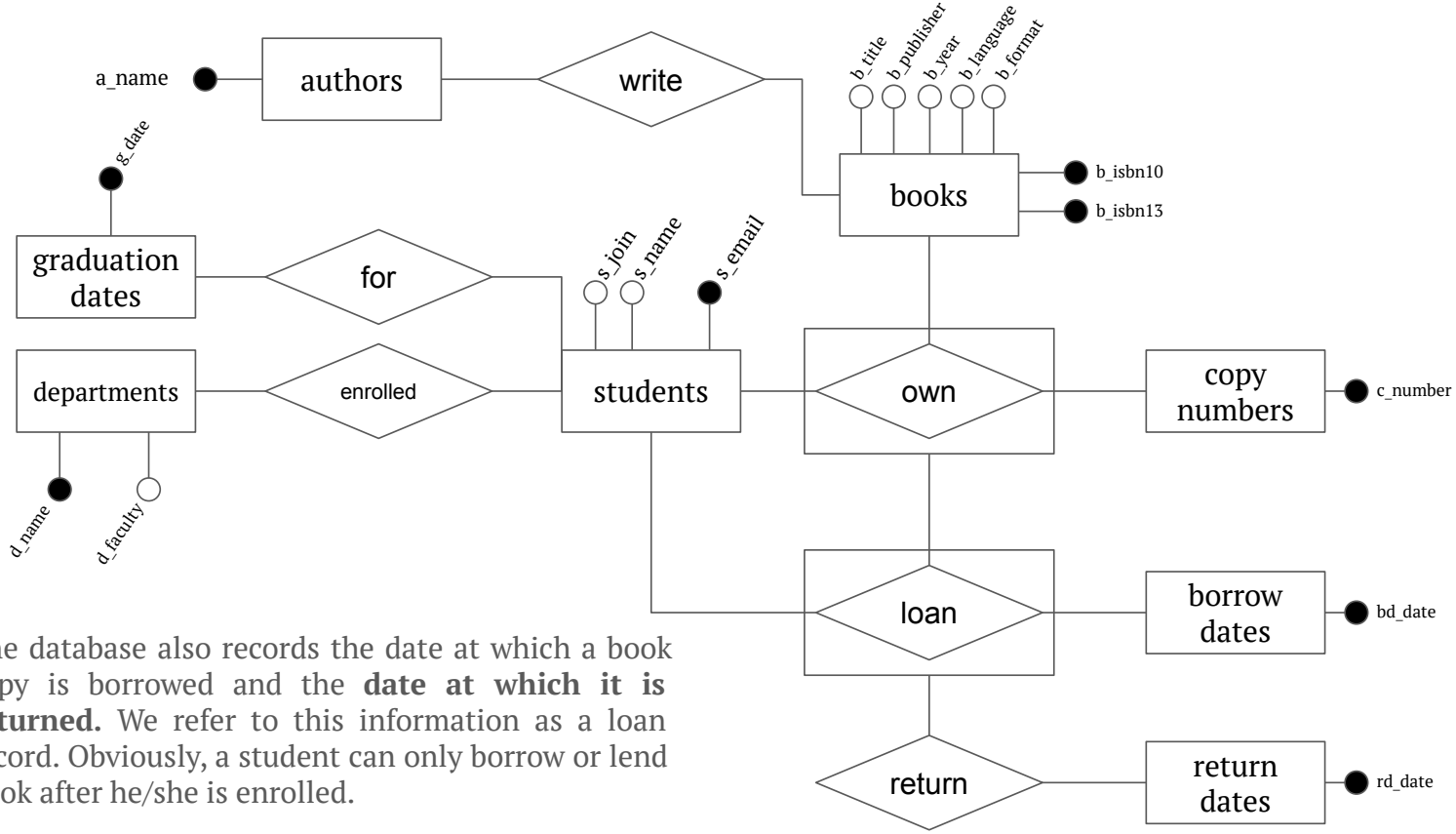

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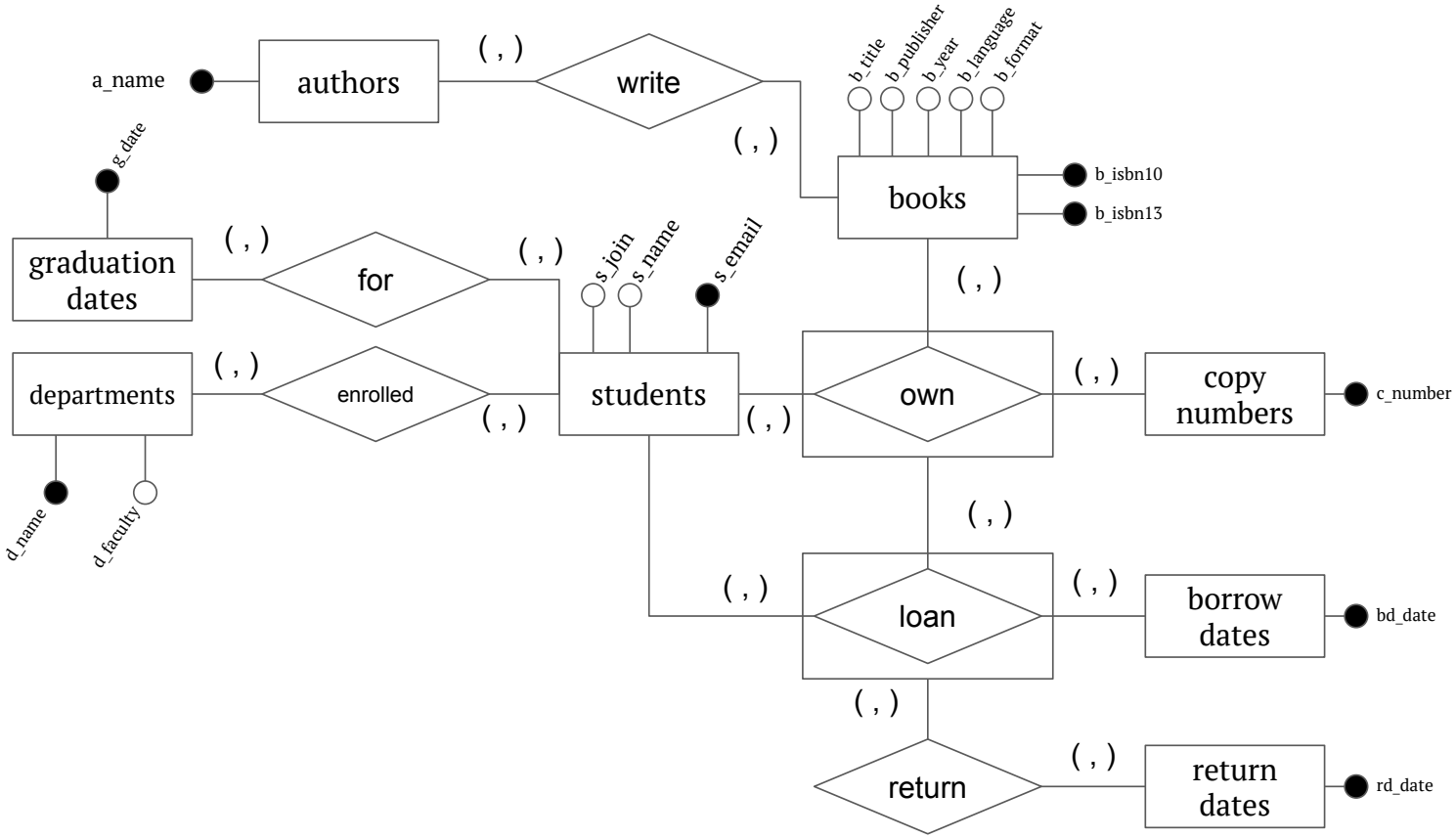

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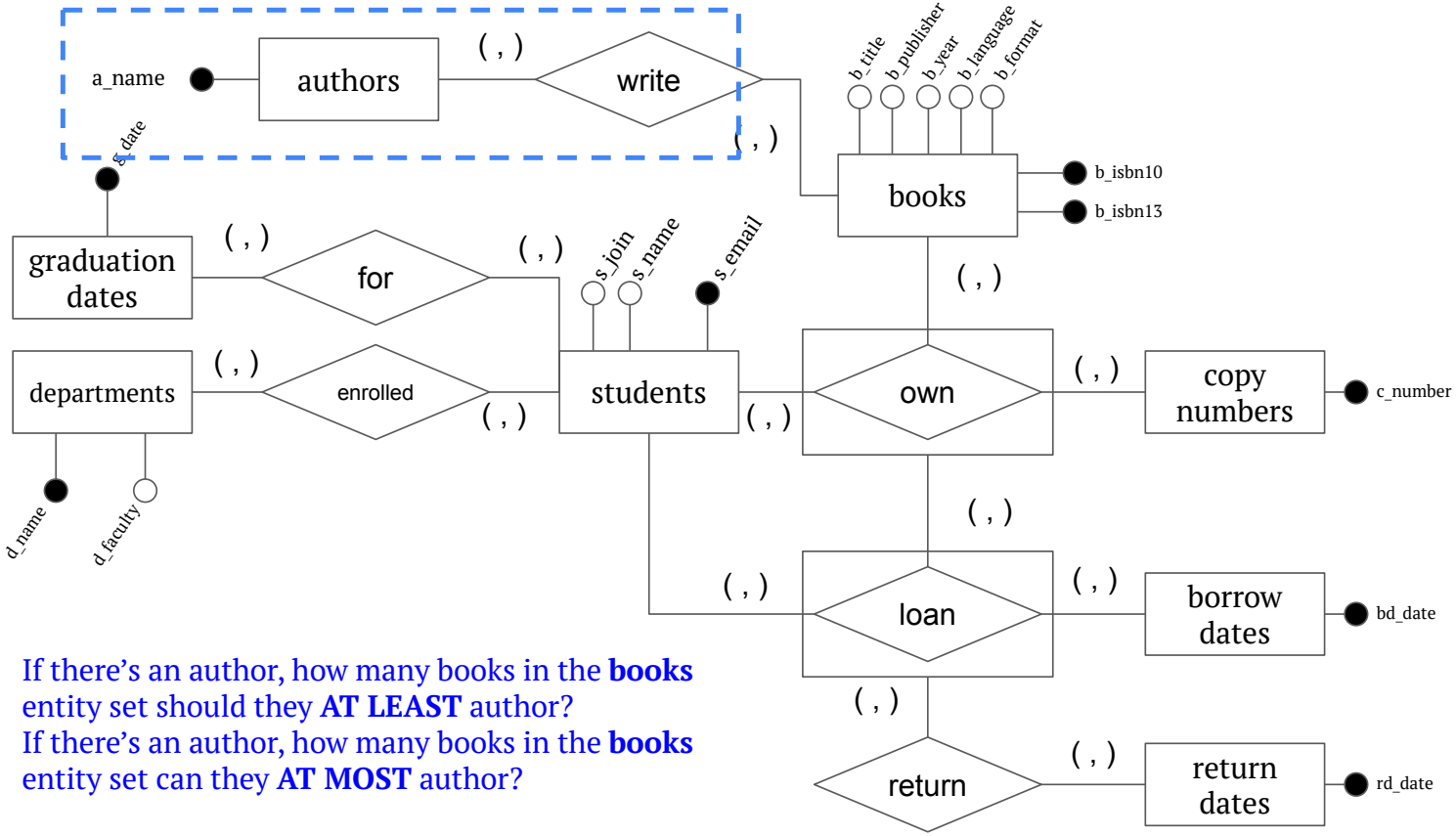
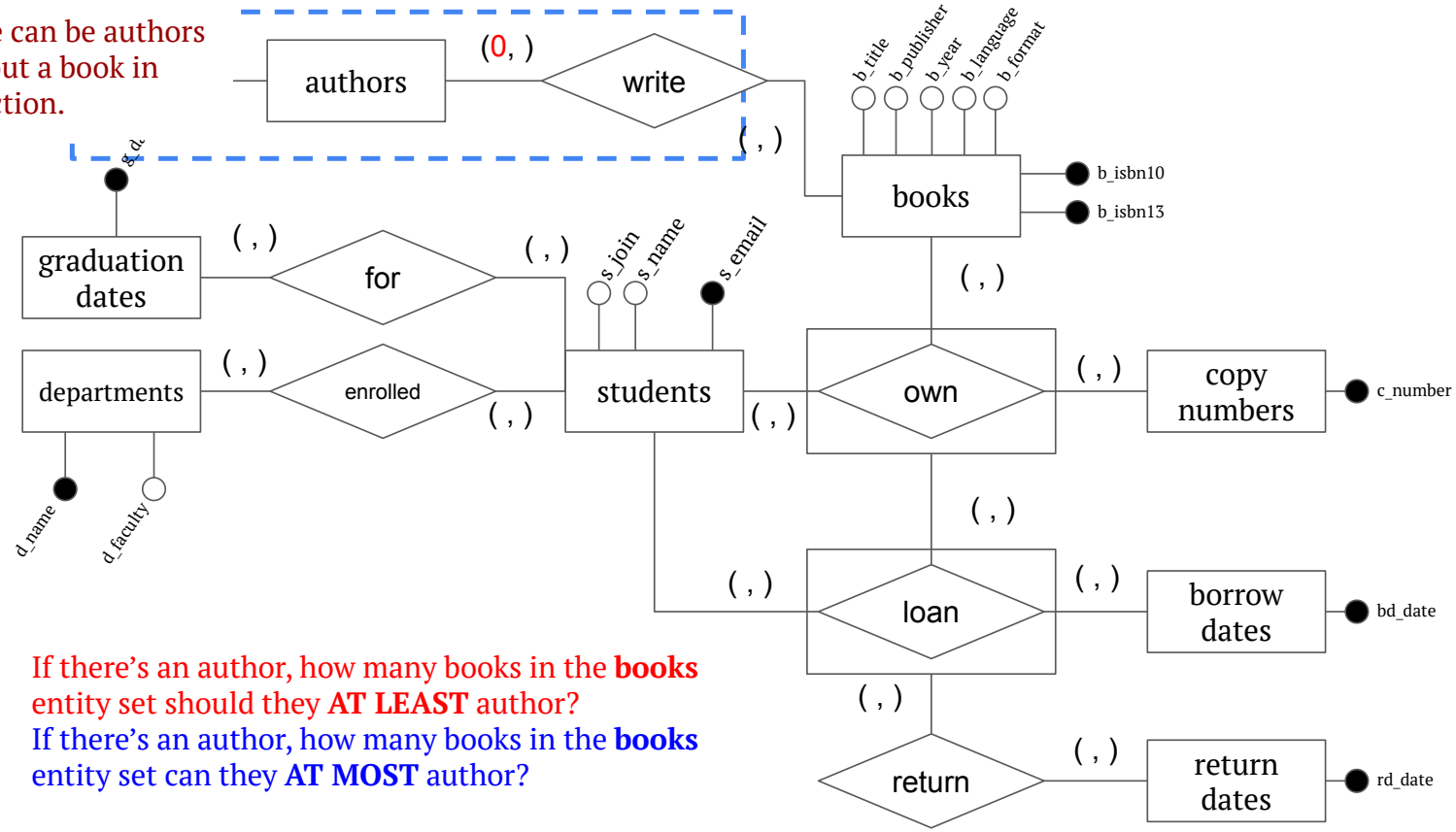


1. If there's an author, how many books in the **books** entity set should they **AT LEAST** author?
2. If there's an author, how many books in the **books** entity set can they **AT MOST** author?

The ER Diagram

There can be authors without a book in collection.



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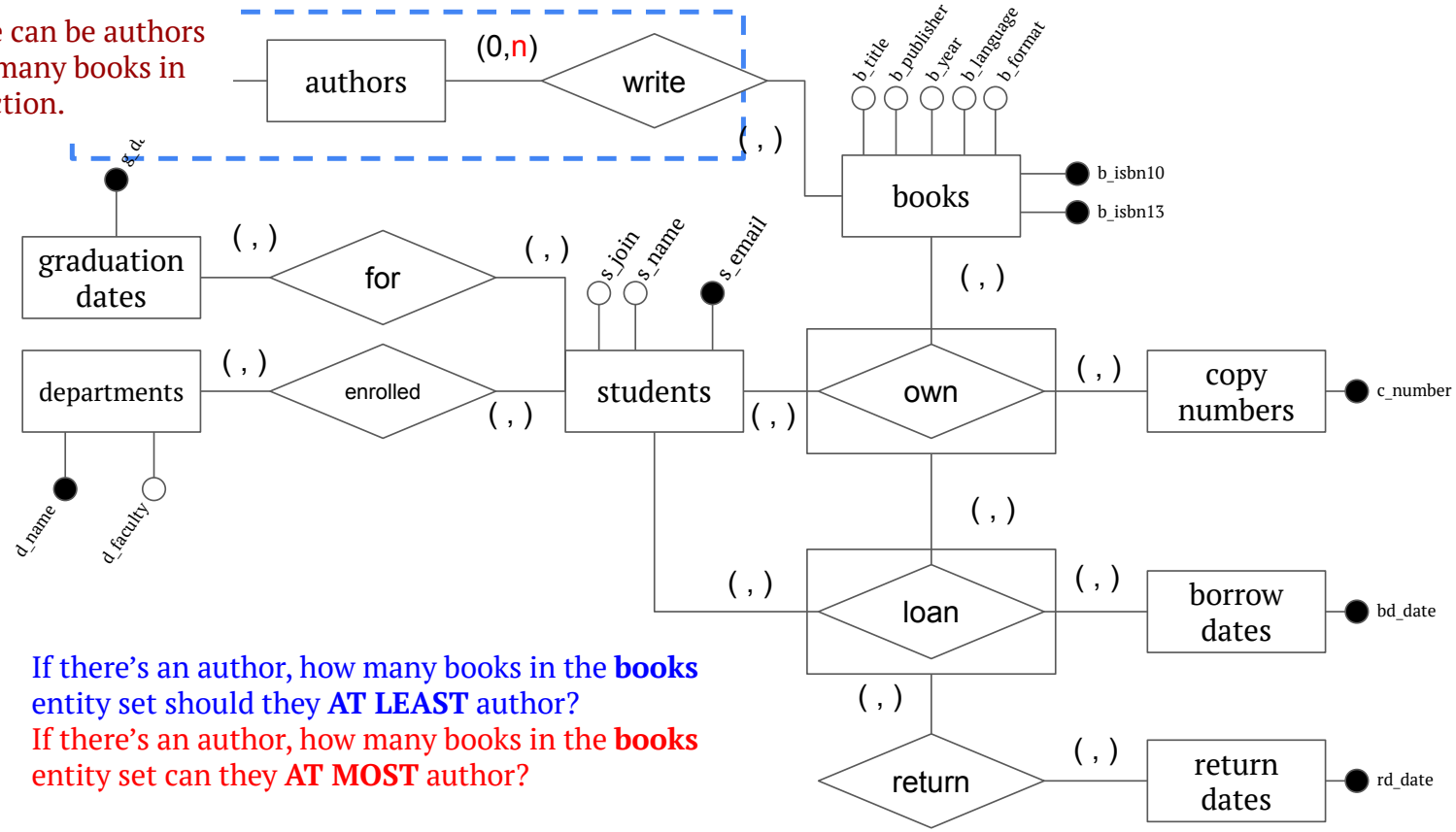
There can be authors with many books in collection.



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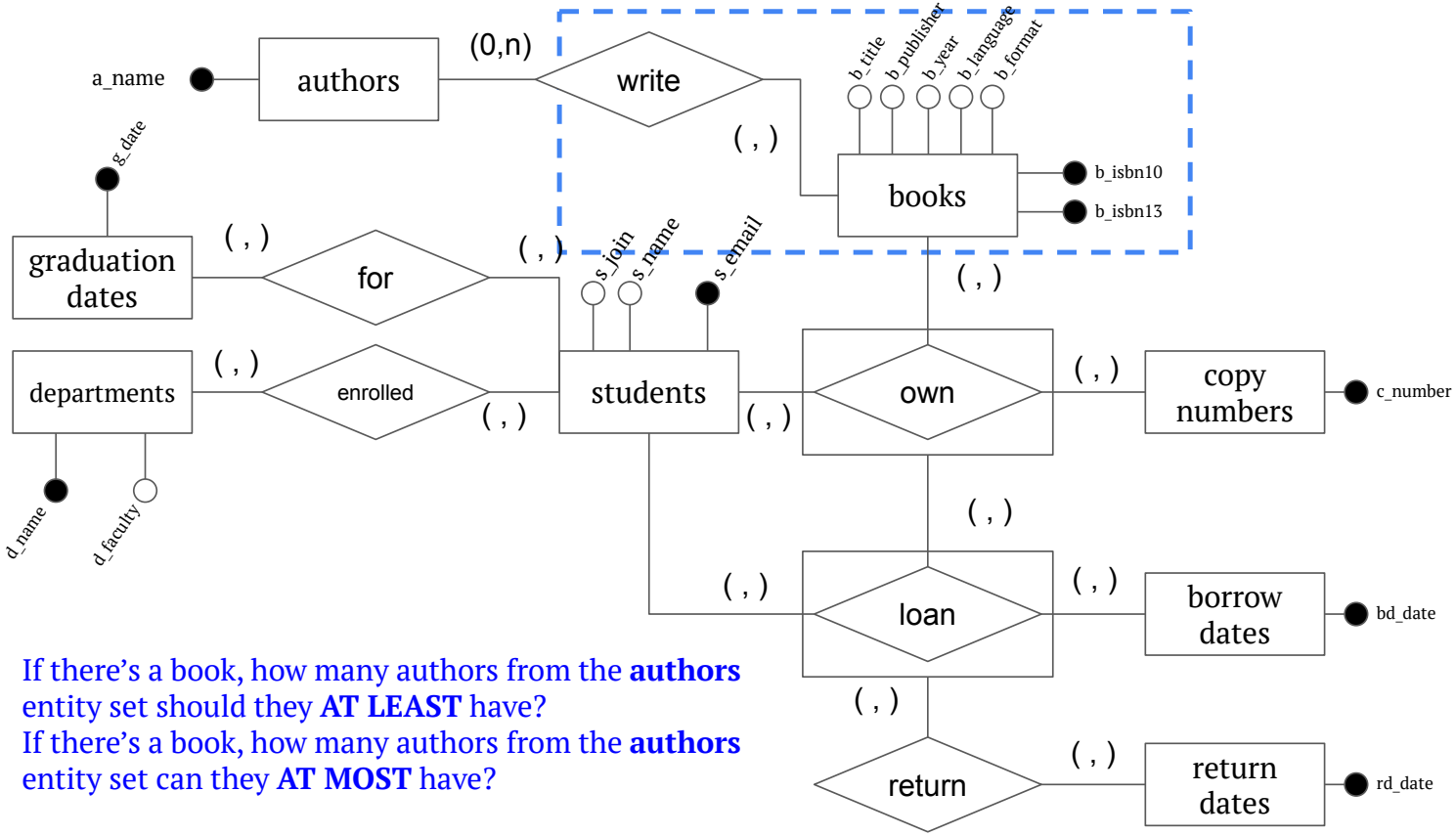

1. If there's a book, how many authors from the **authors** entity set should they **AT LEAST** have?
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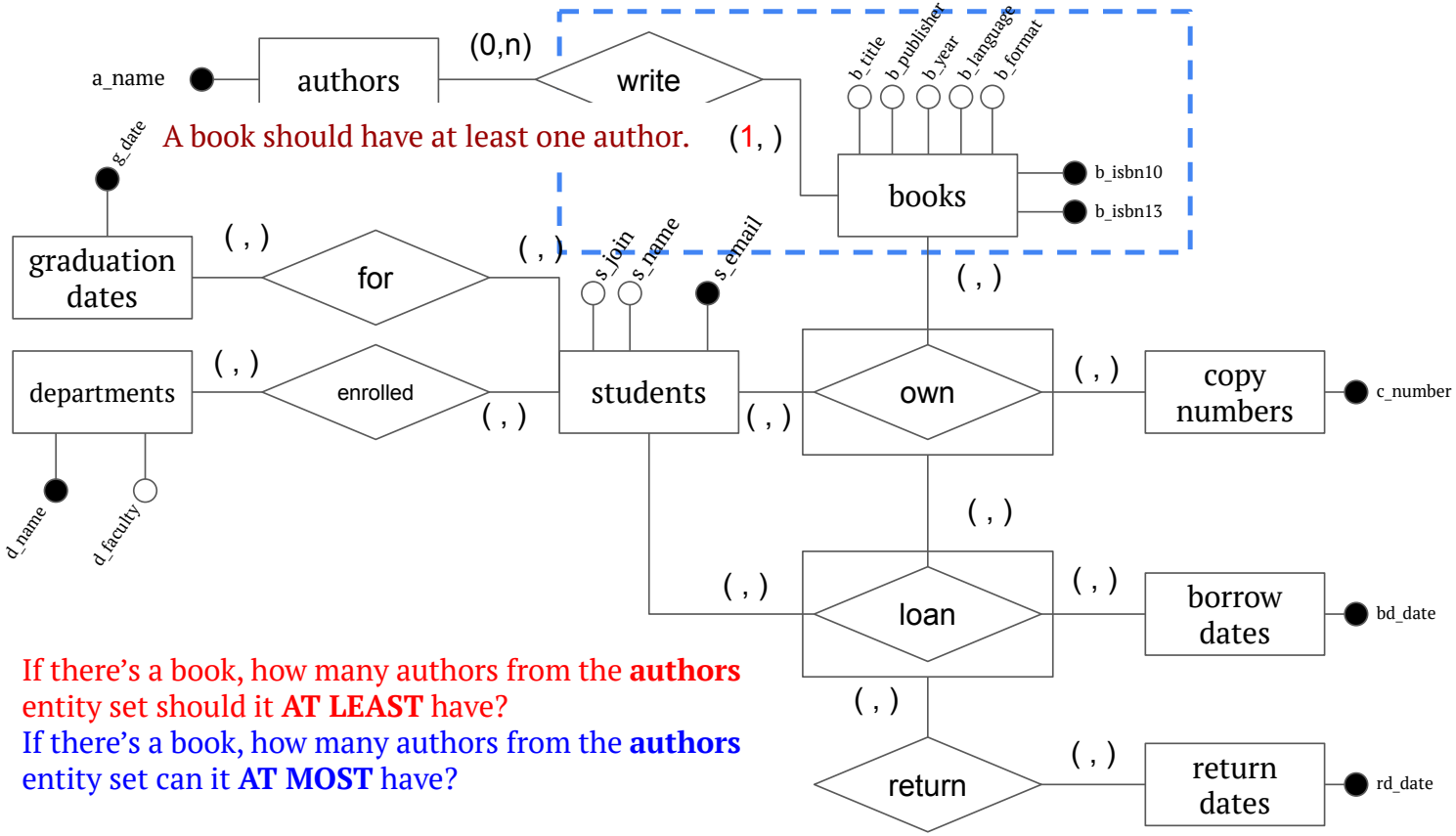

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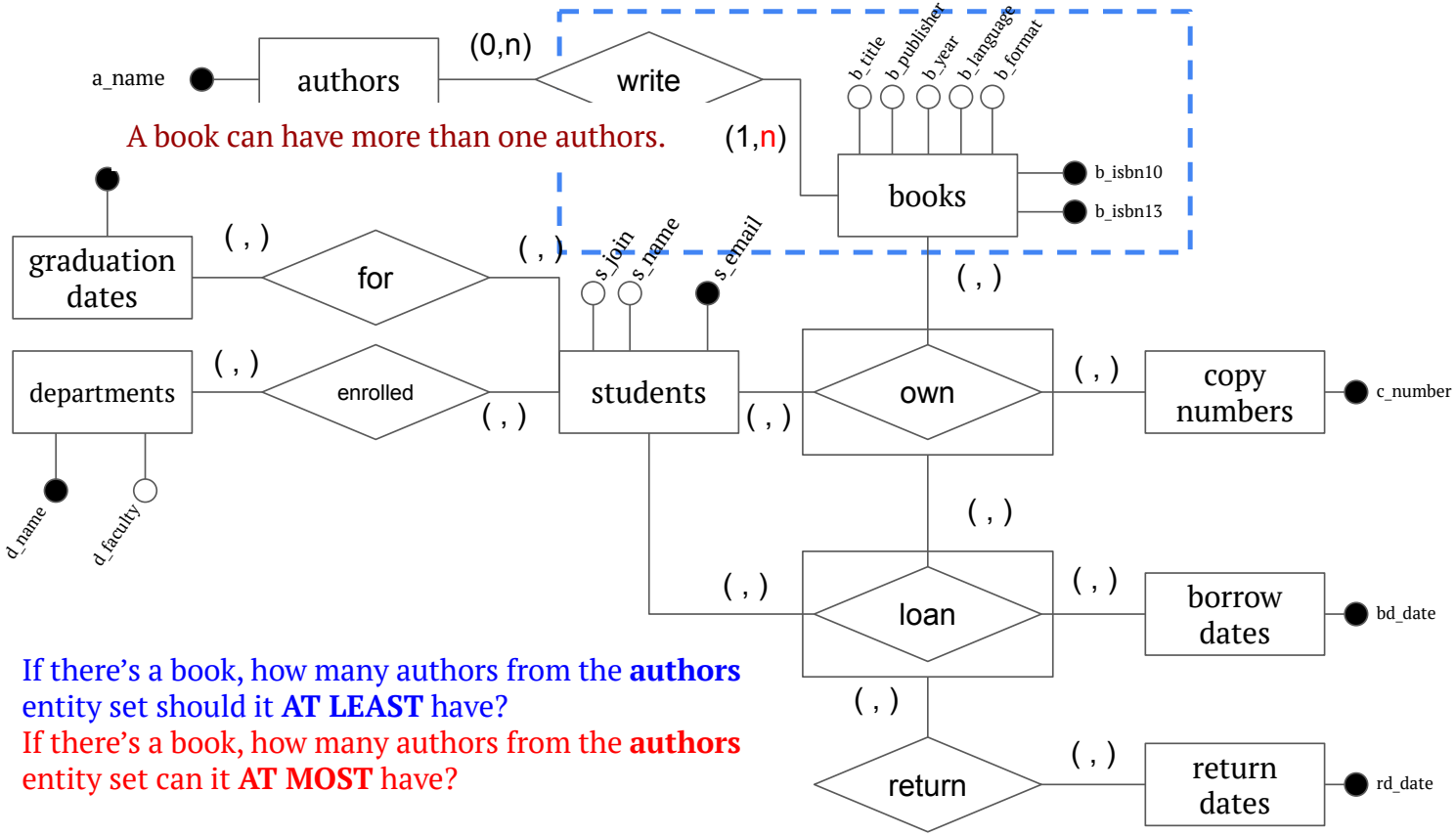

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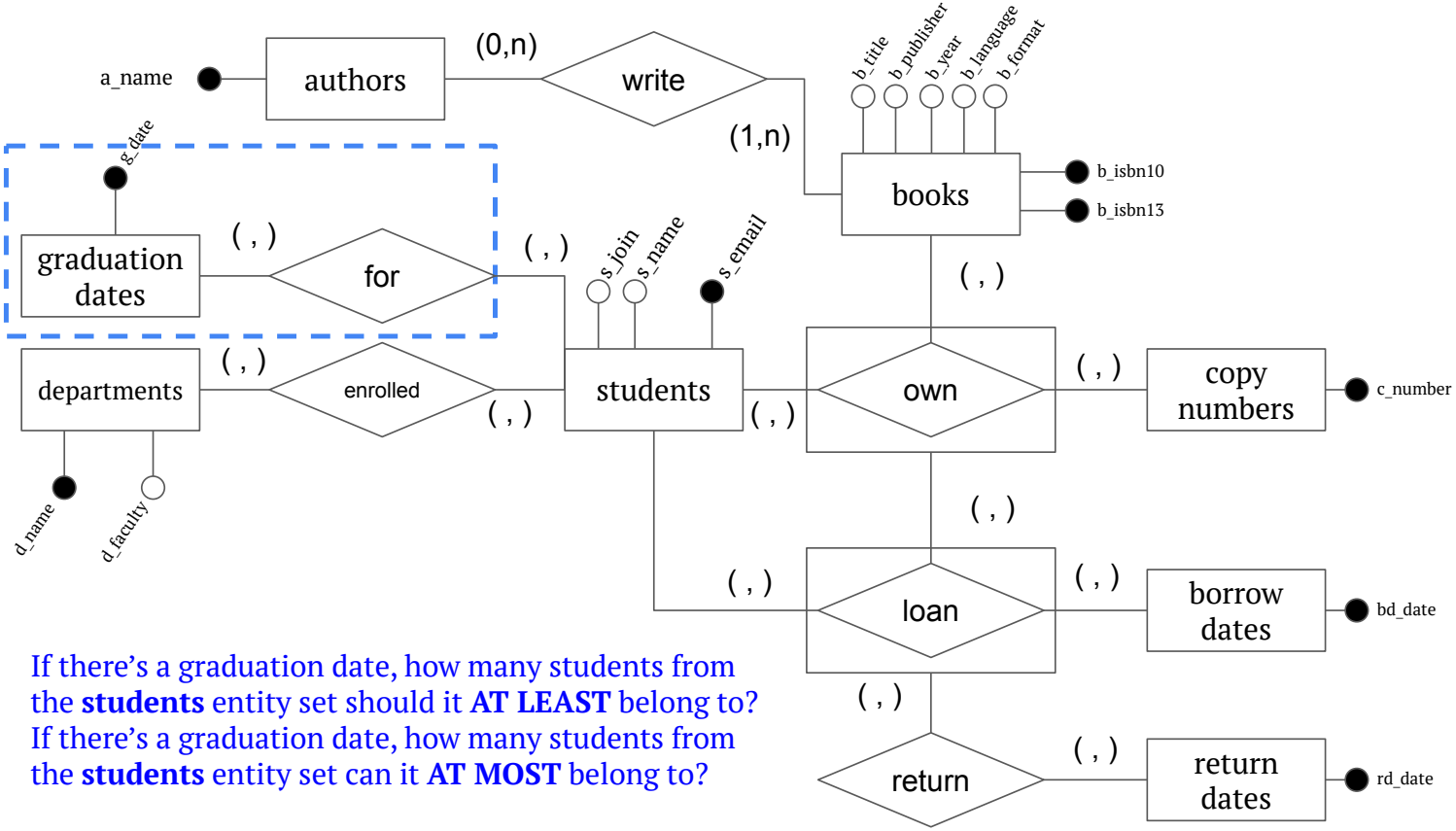

1. If there's a graduation date, how many students from the **students** entity set should it **AT LEAST** belong to?
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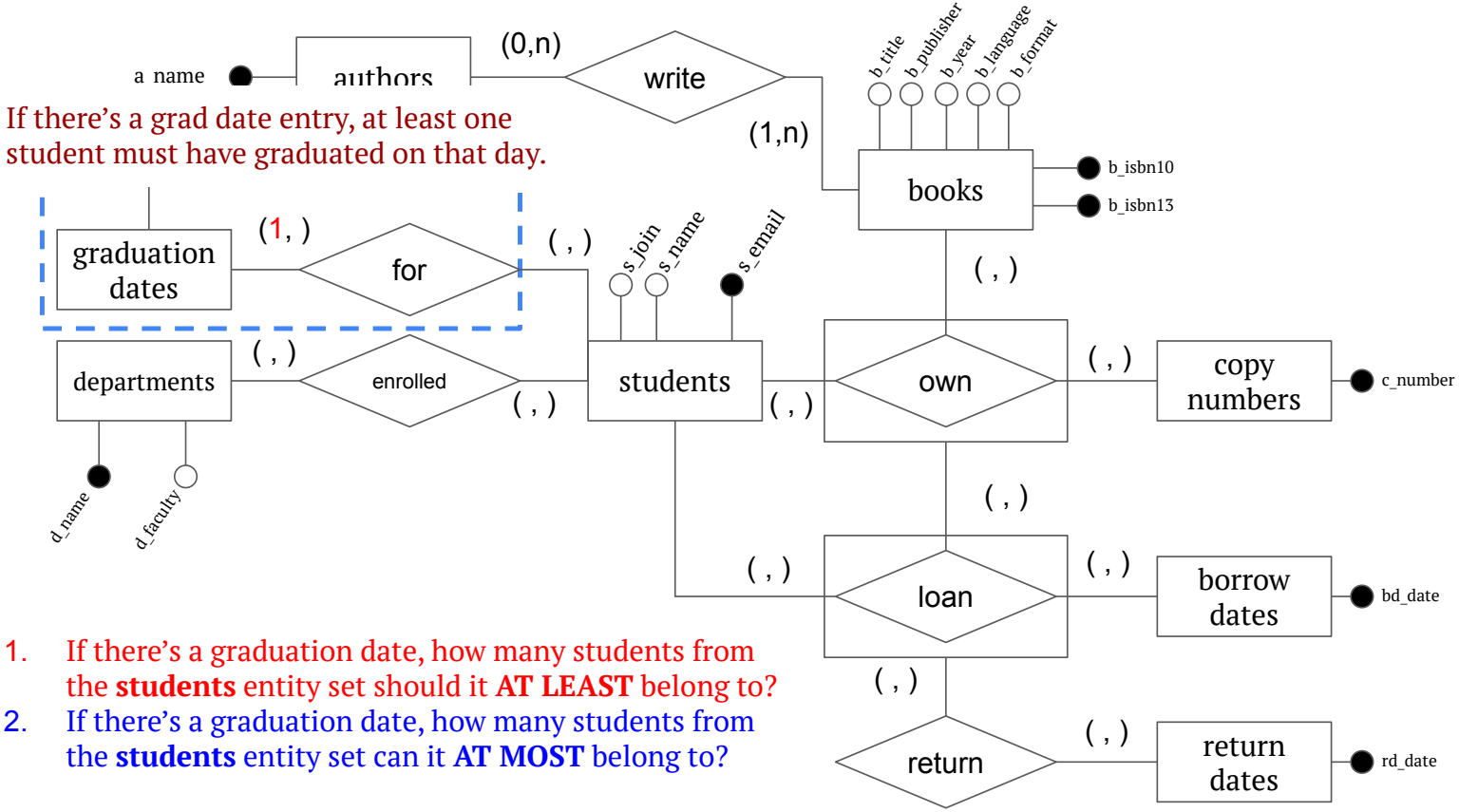

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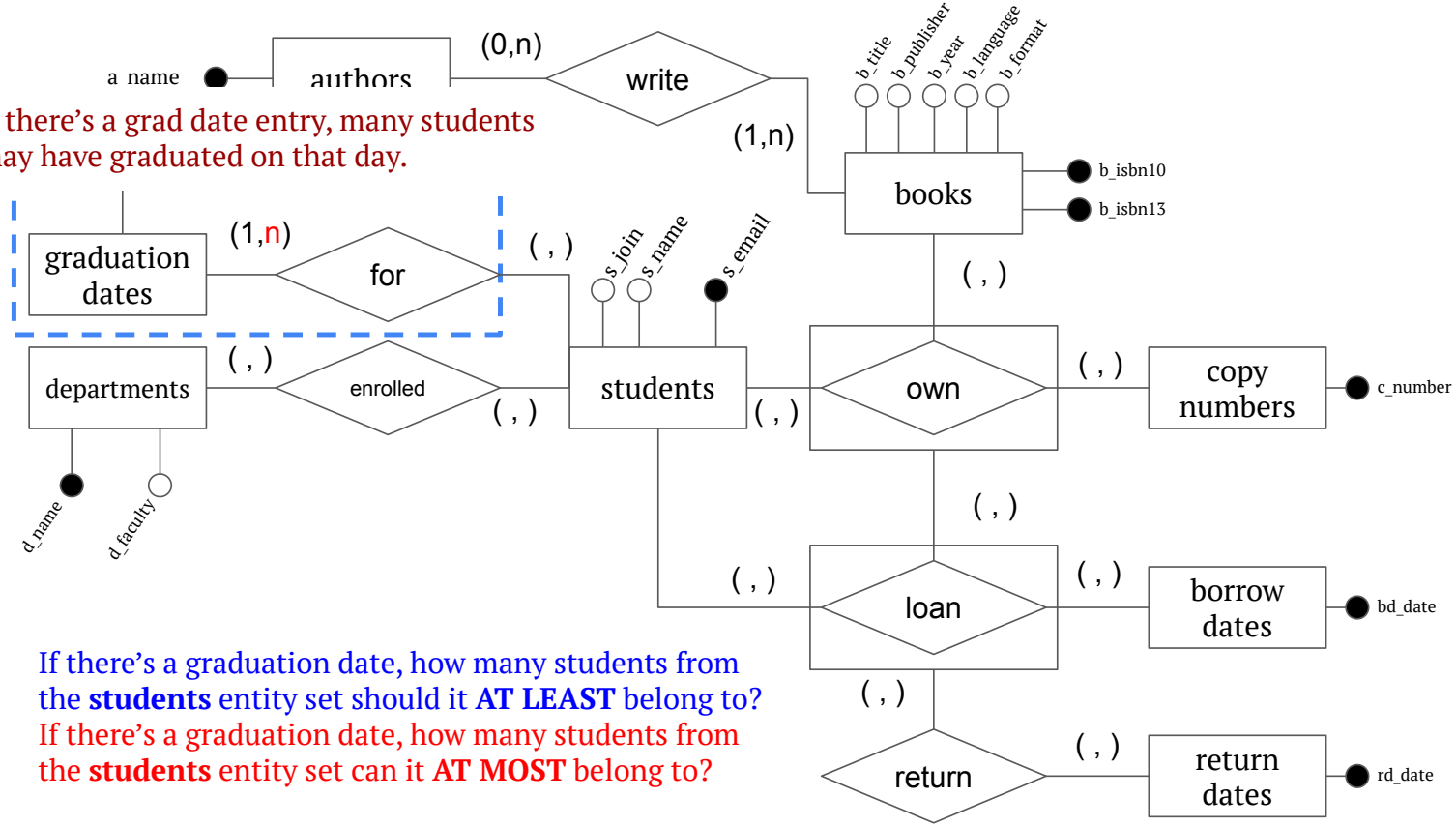

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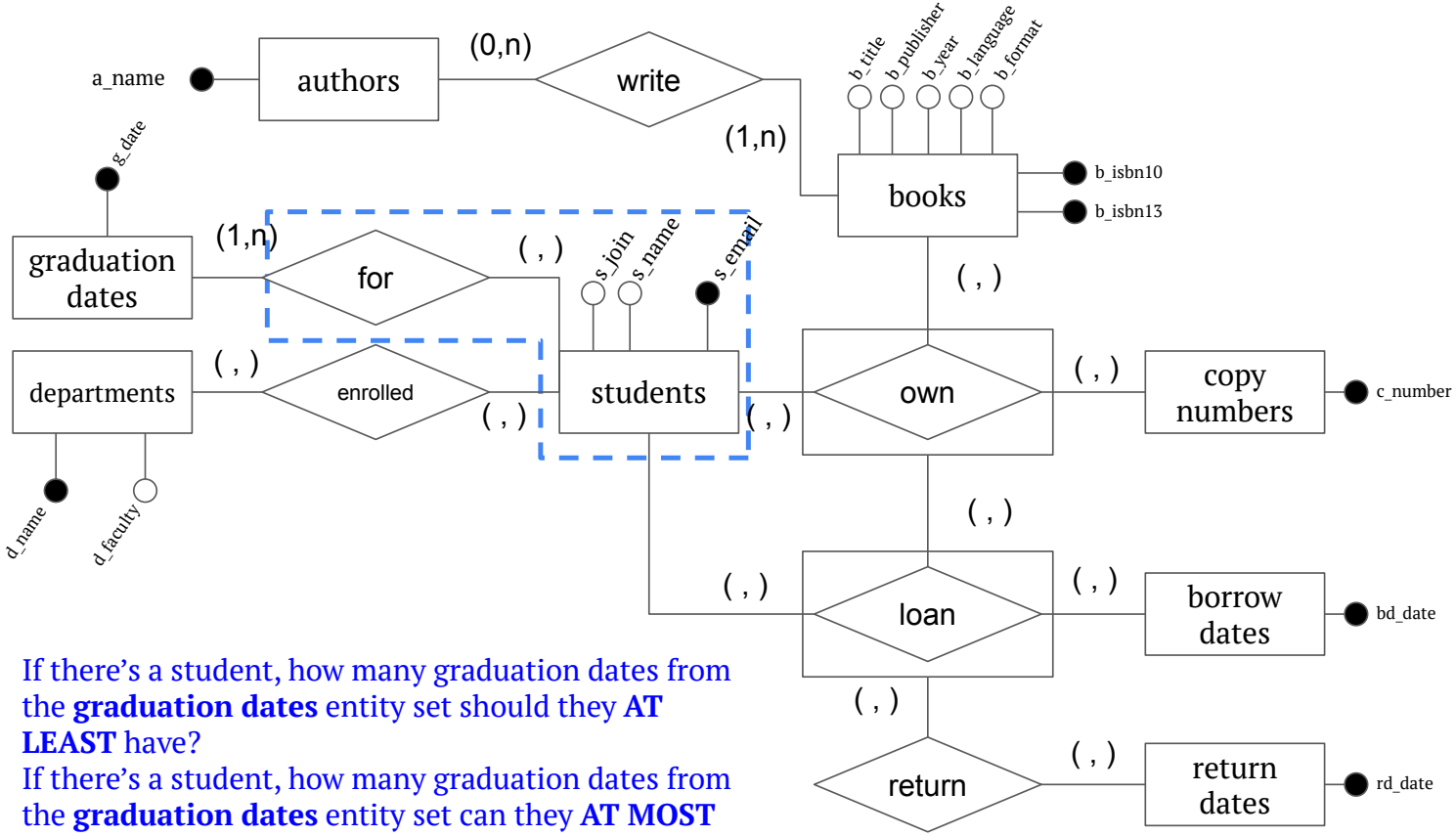

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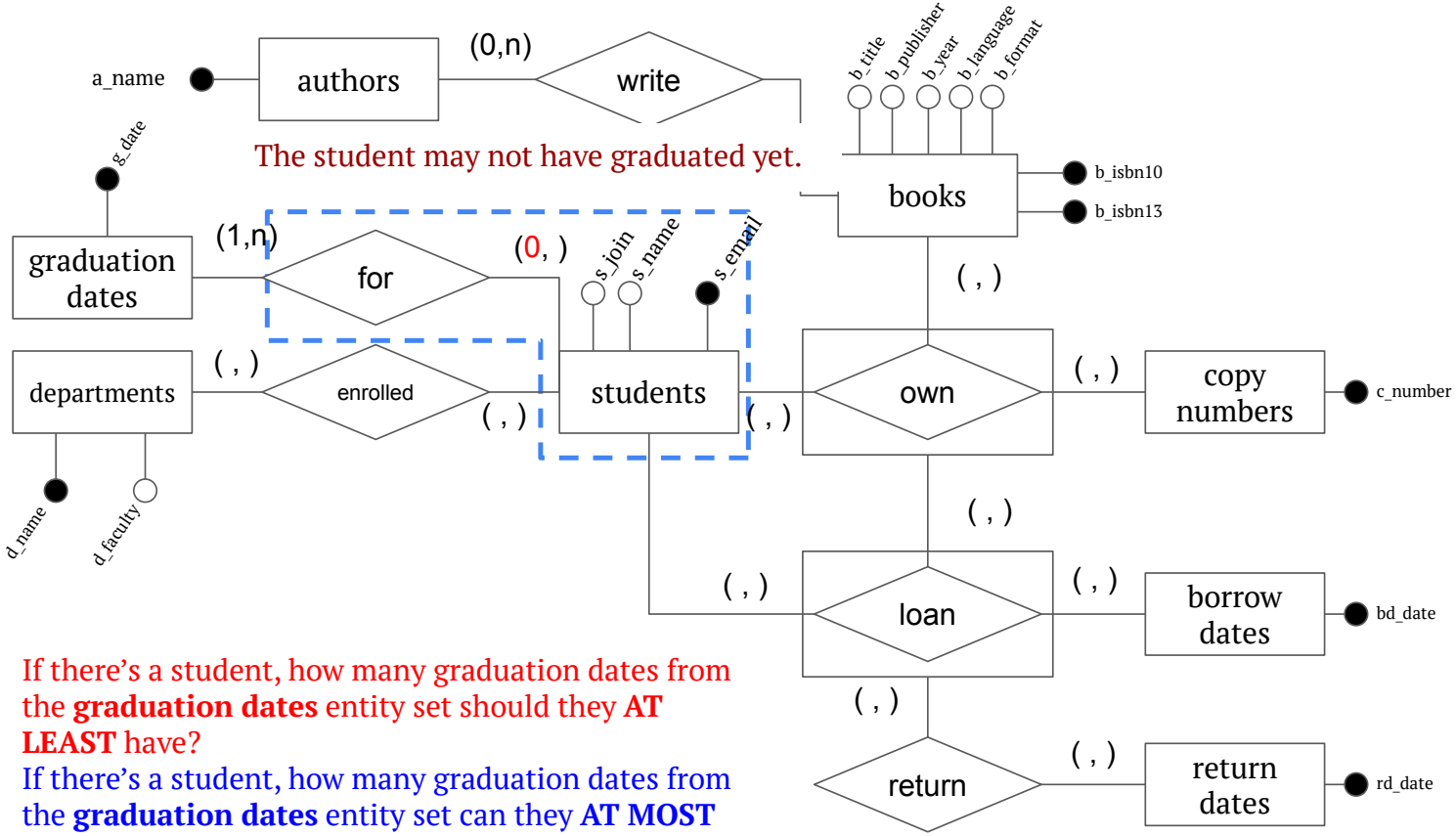

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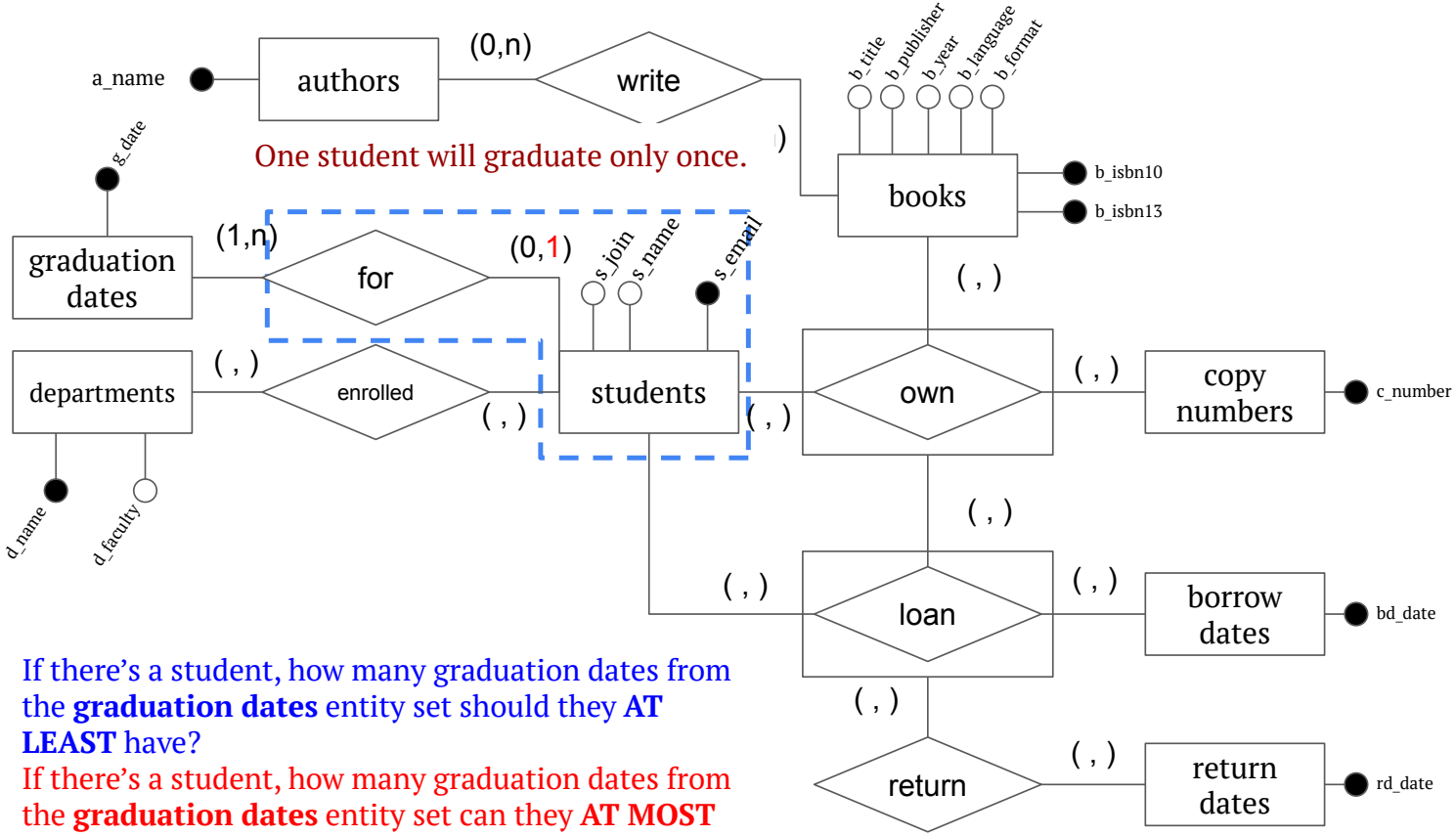

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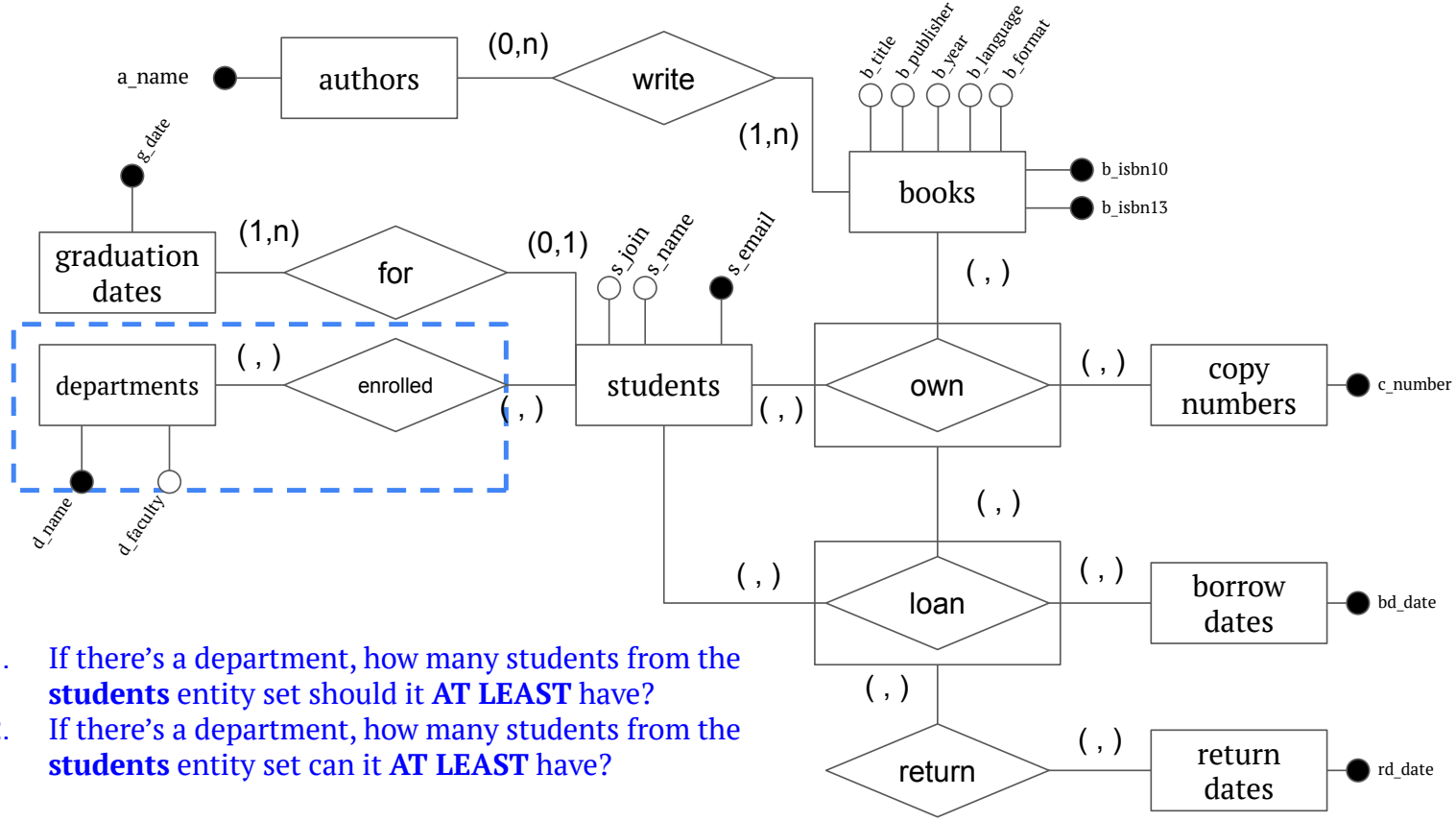

1. If there's a department, how many students from the **students** entity set should it **AT LEAST** have?
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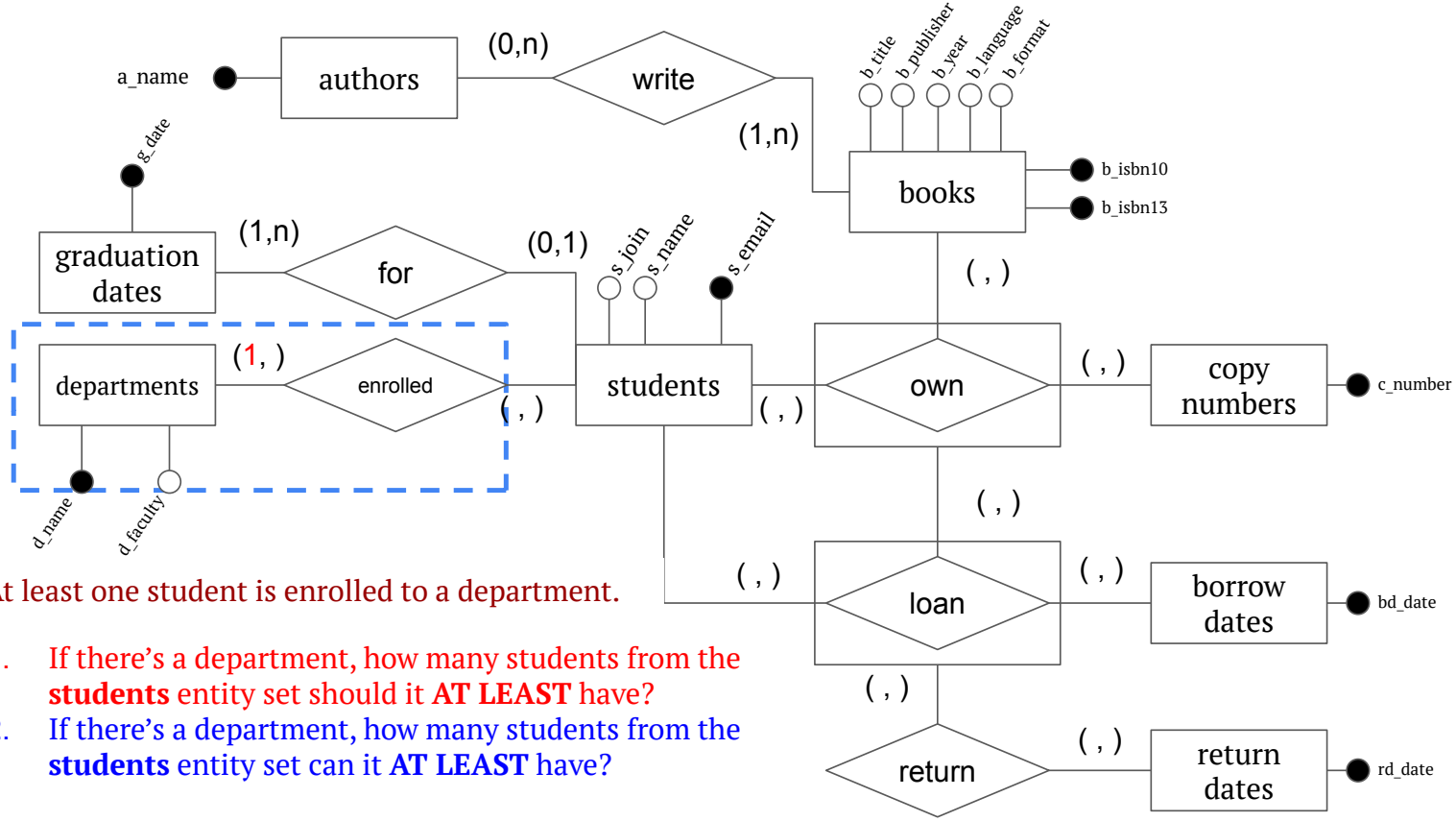

At least one student is enrolled to a department.

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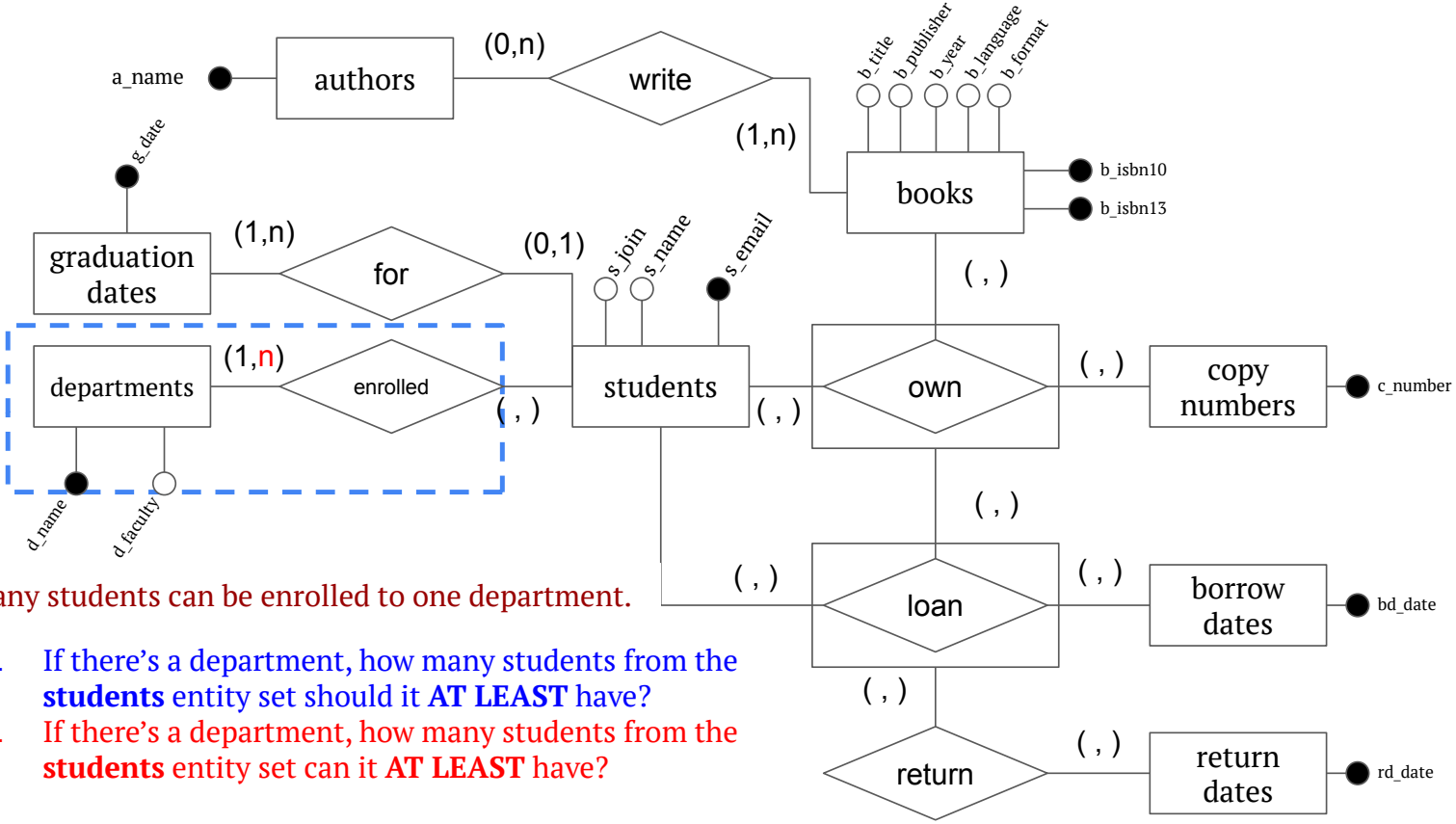

Many students can be enrolled to one department.

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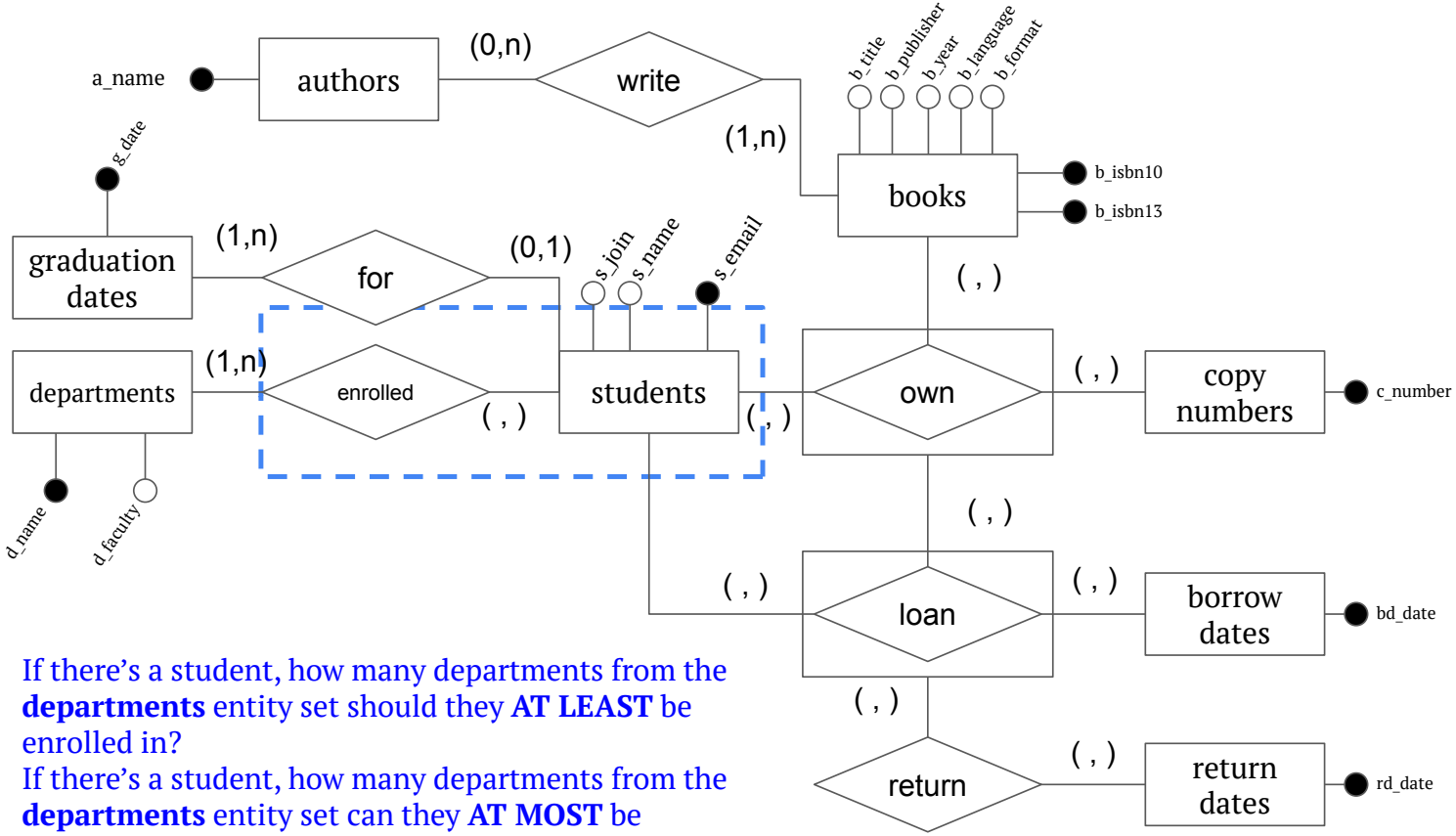

1. If there's a student, how many departments from the **departments** entity set should they **AT LEAST** be enrolled in?
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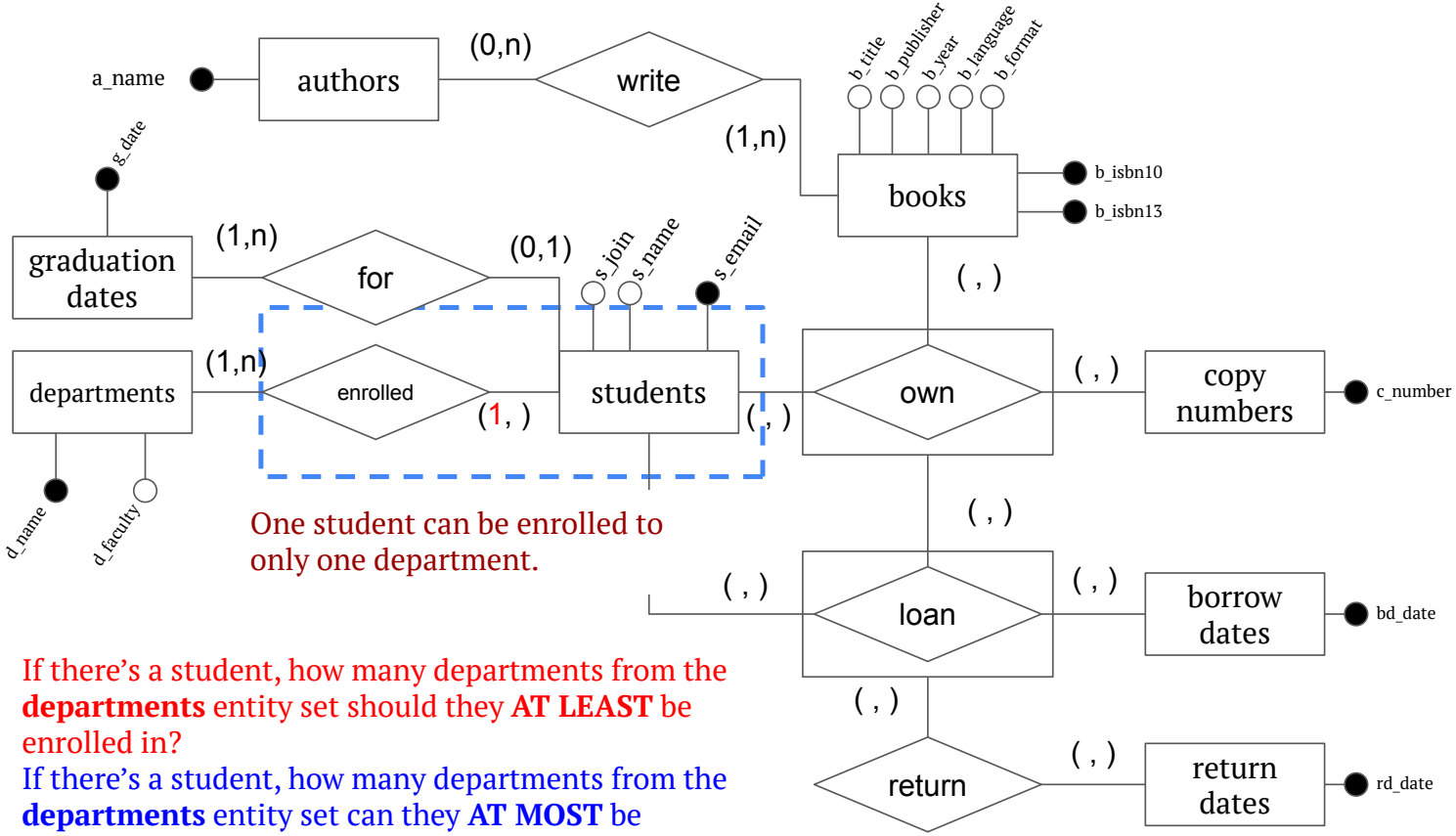

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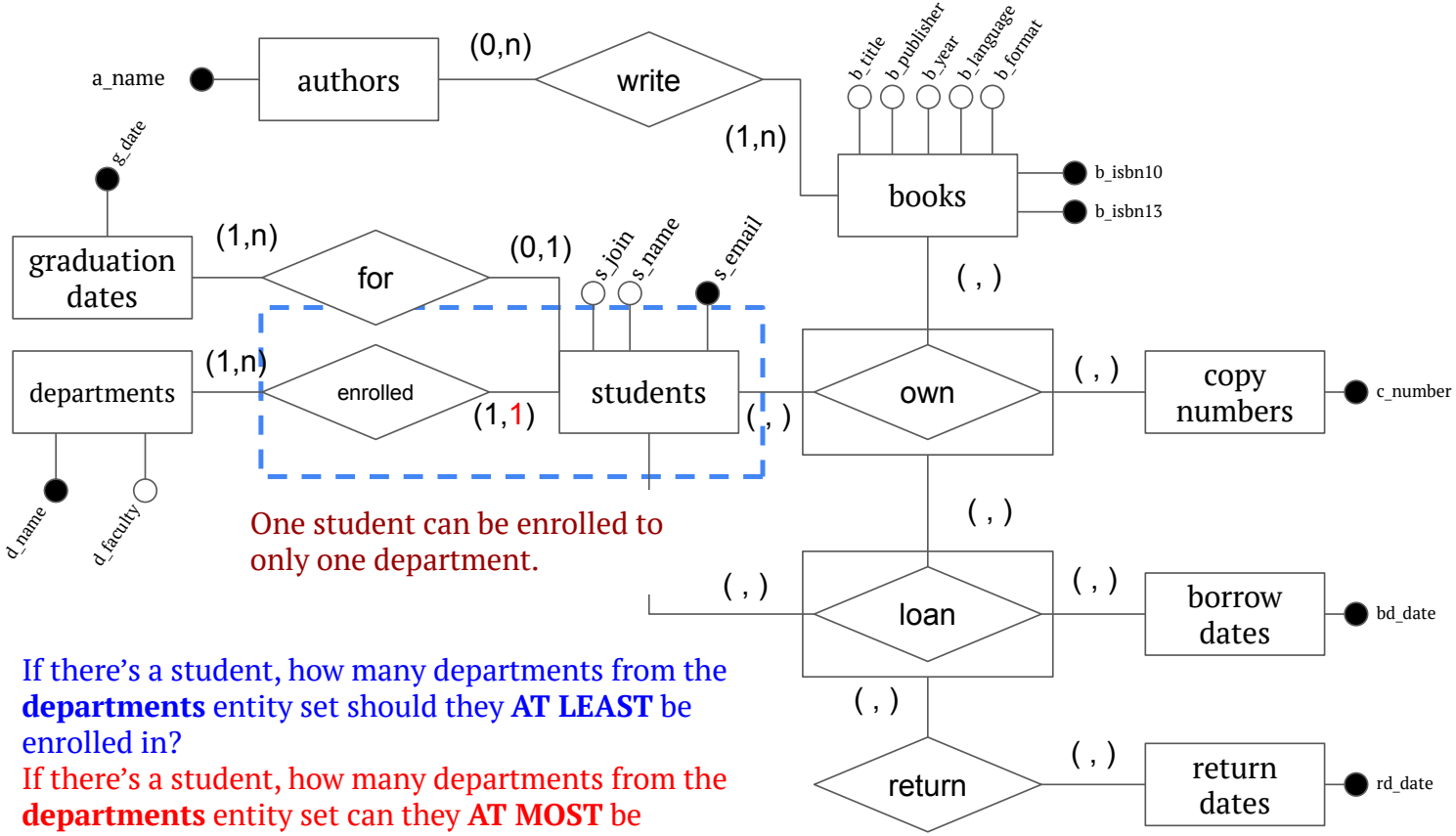

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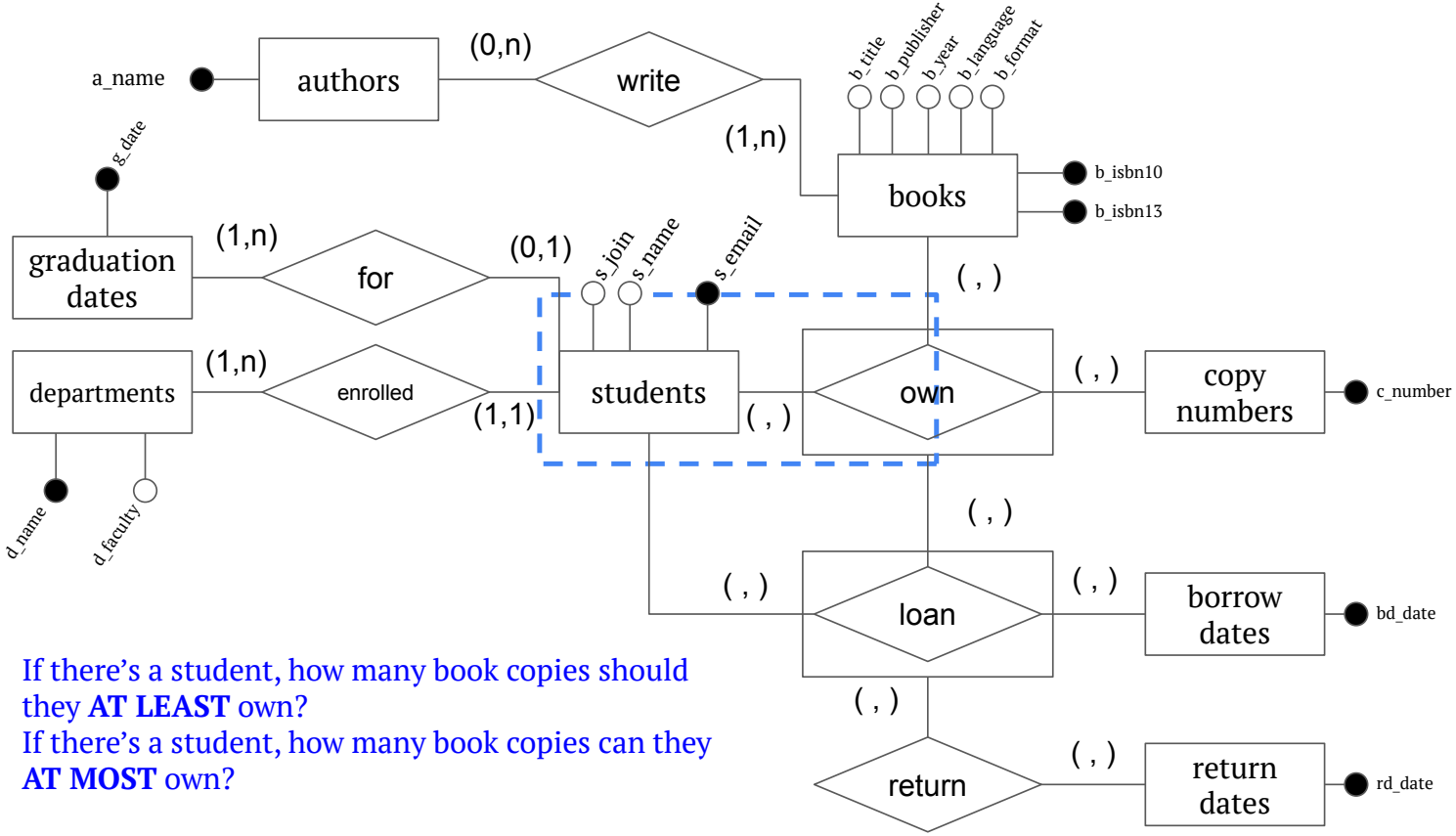

1. If there's a student, how many book copies should they **AT LEAST** own?
2. If there's a student, how many book copies can they **AT MOST** own?

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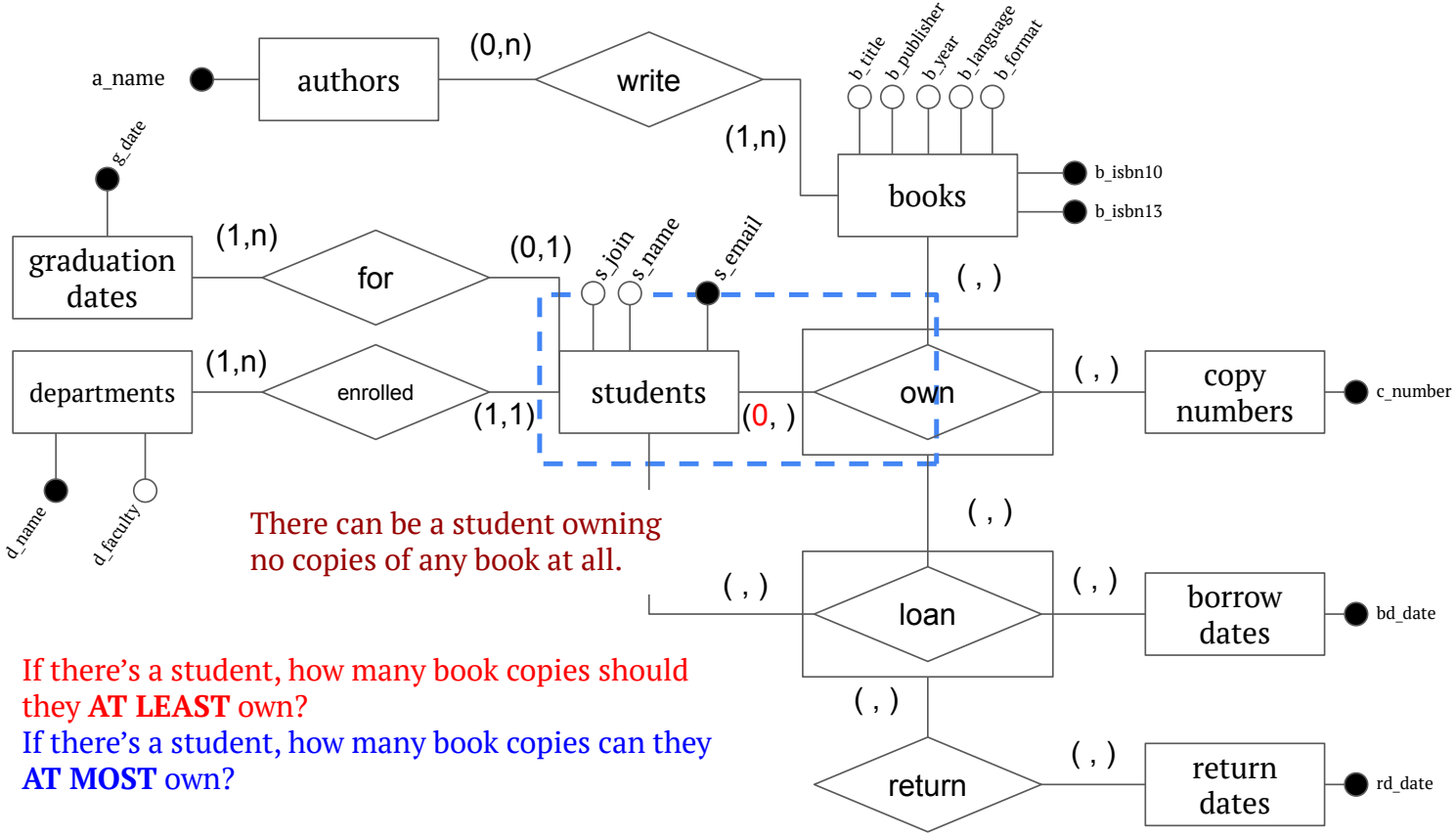

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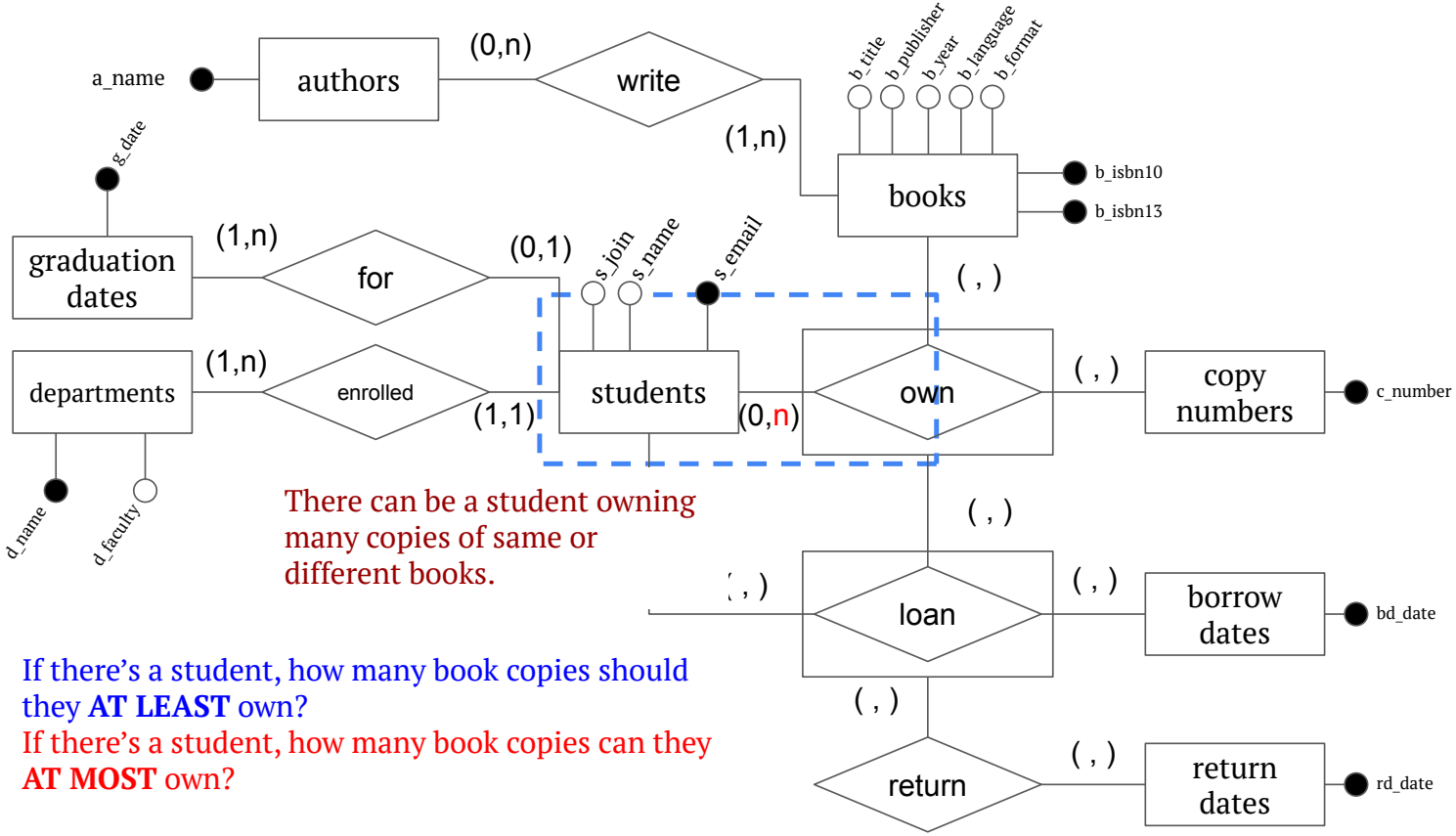

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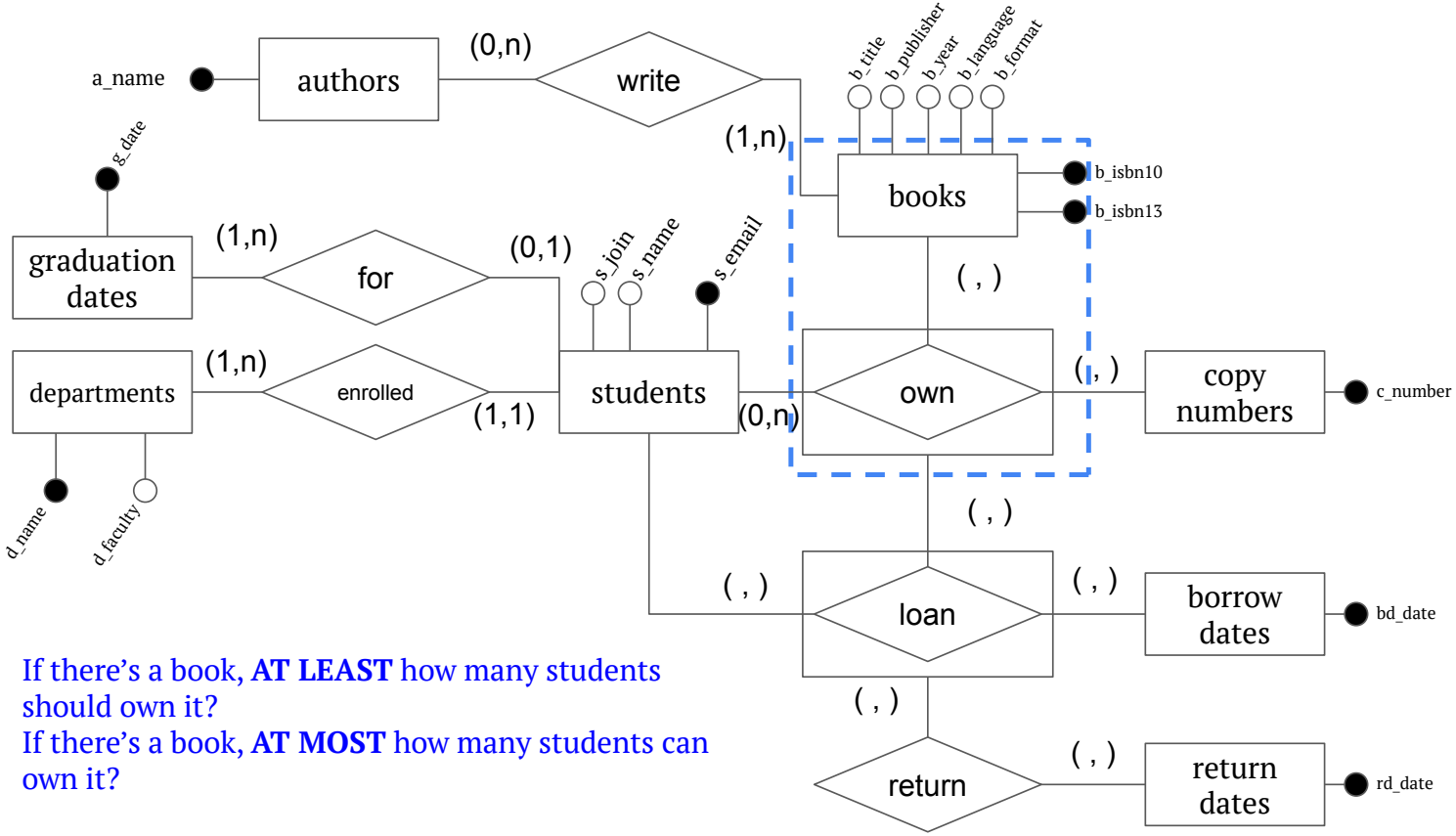

1. If there's a book, **AT LEAST** how many students should own it?
2. If there's a book, **AT MOST** how many students can own it?

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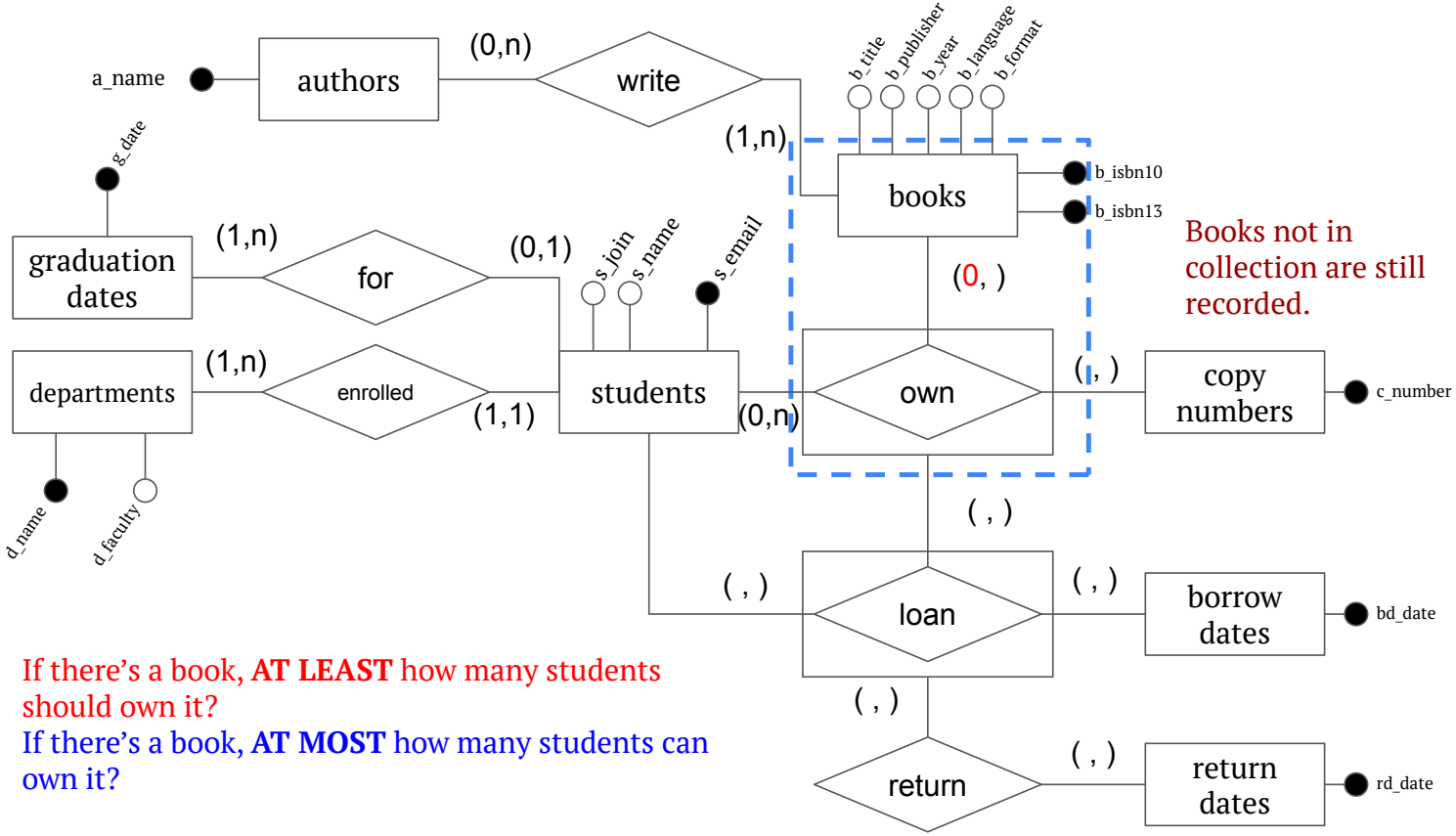

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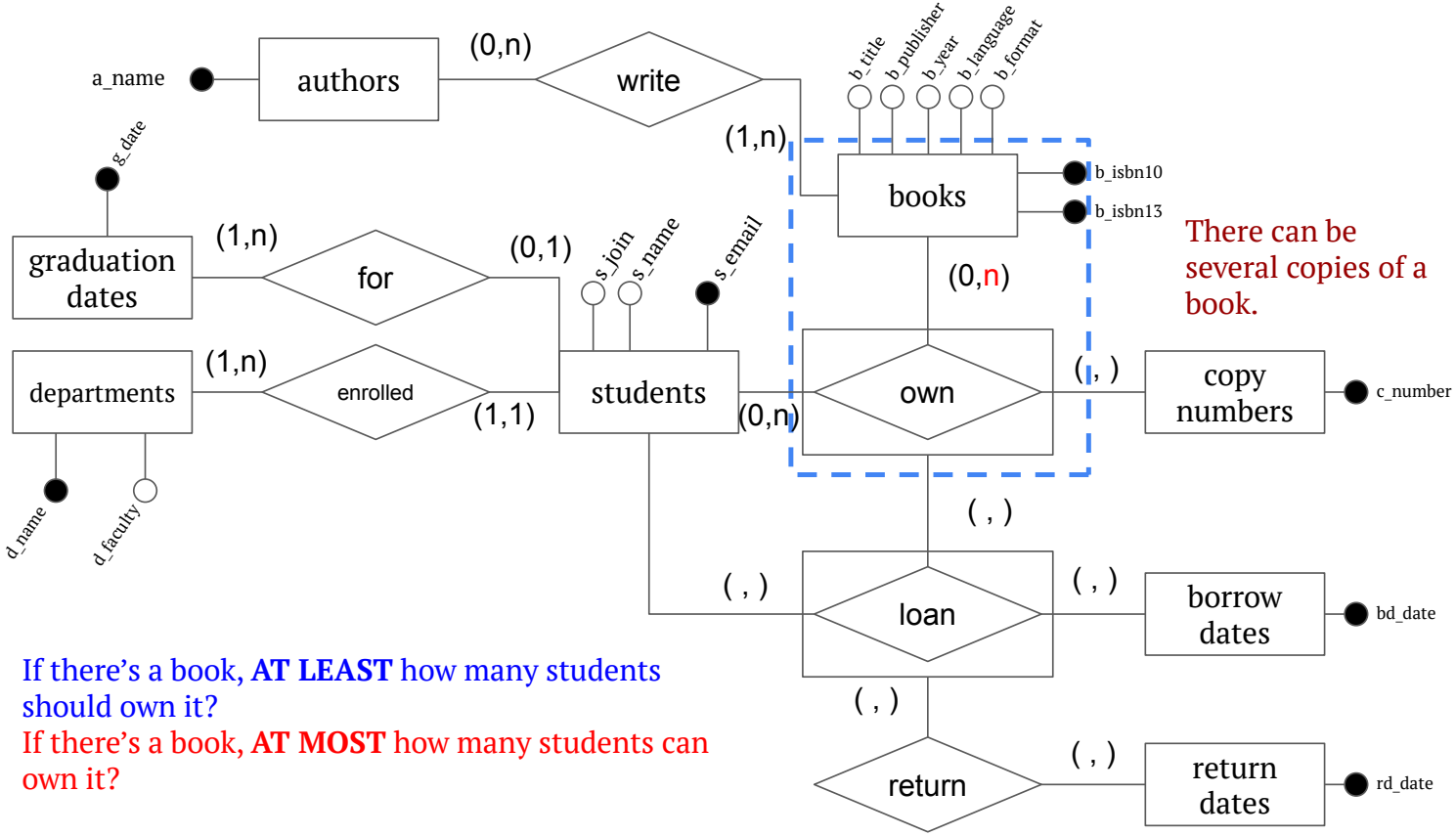
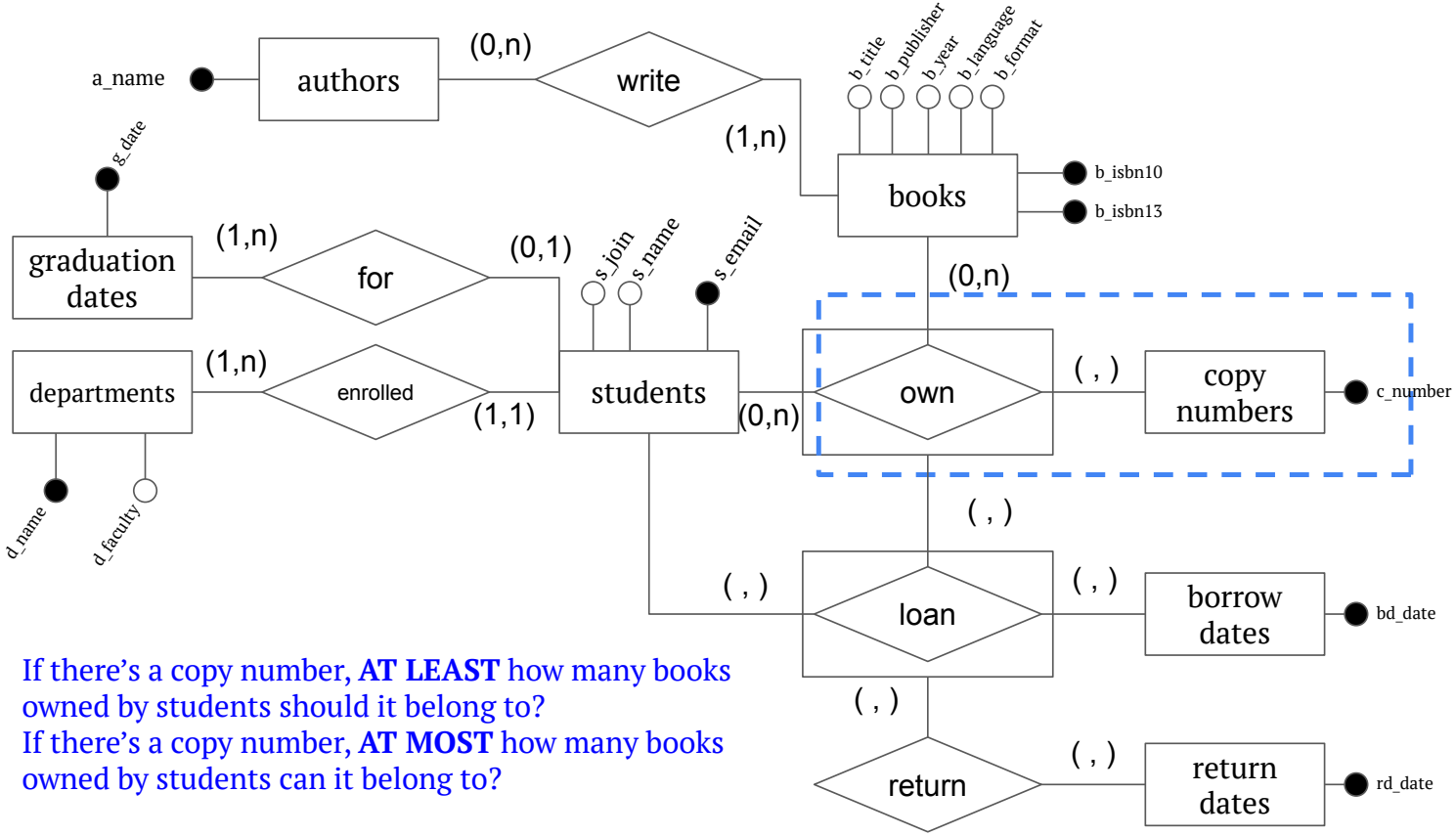
2. If there's a book, **AT MOST** how many students can own it?

The ER Diagram



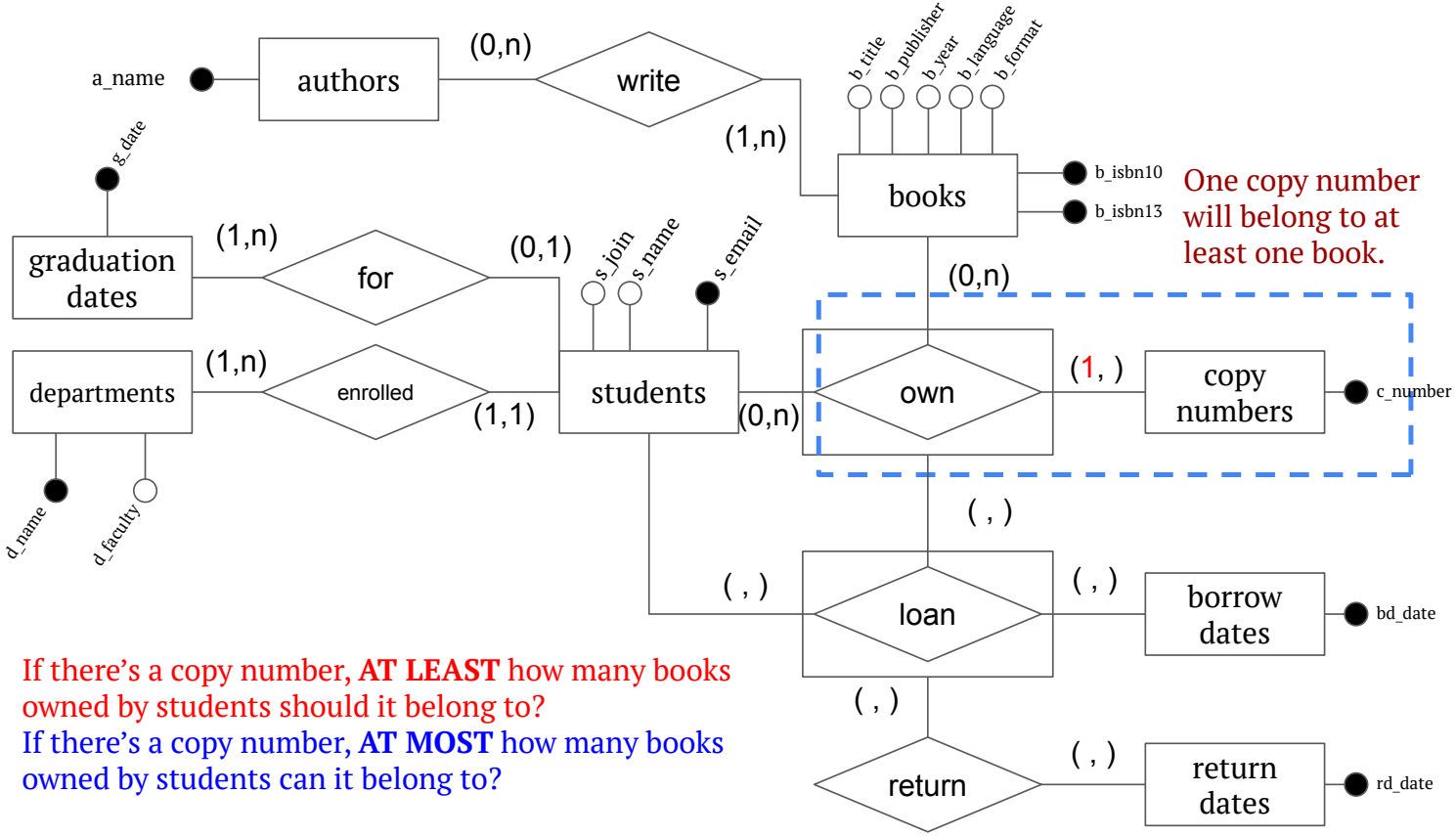
1. If there's a book, **AT LEAST** how many students should own it?
2. If there's a book, **AT MOST** how many students can own it?

The ER Diagram



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

The ER Diagram



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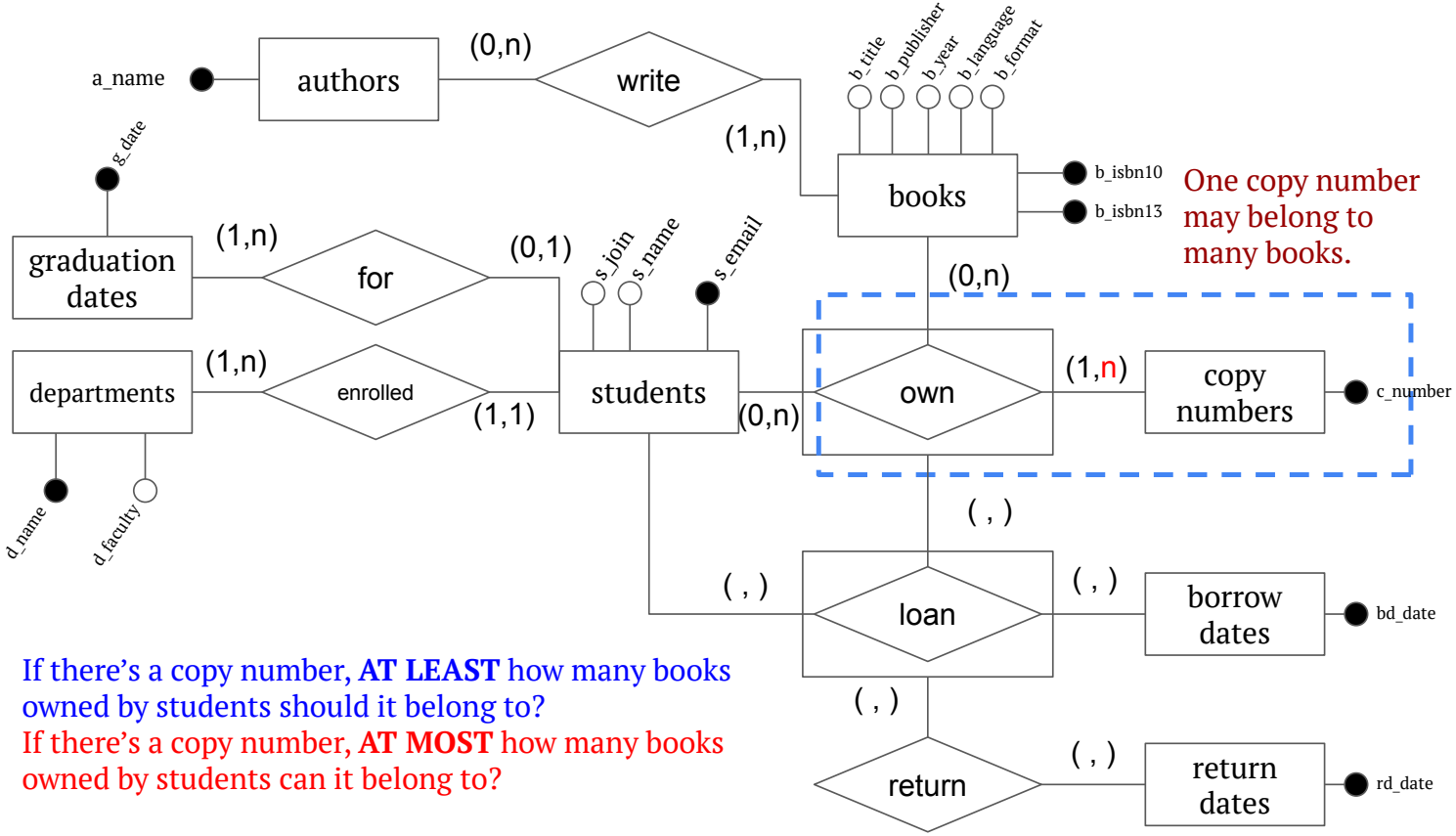

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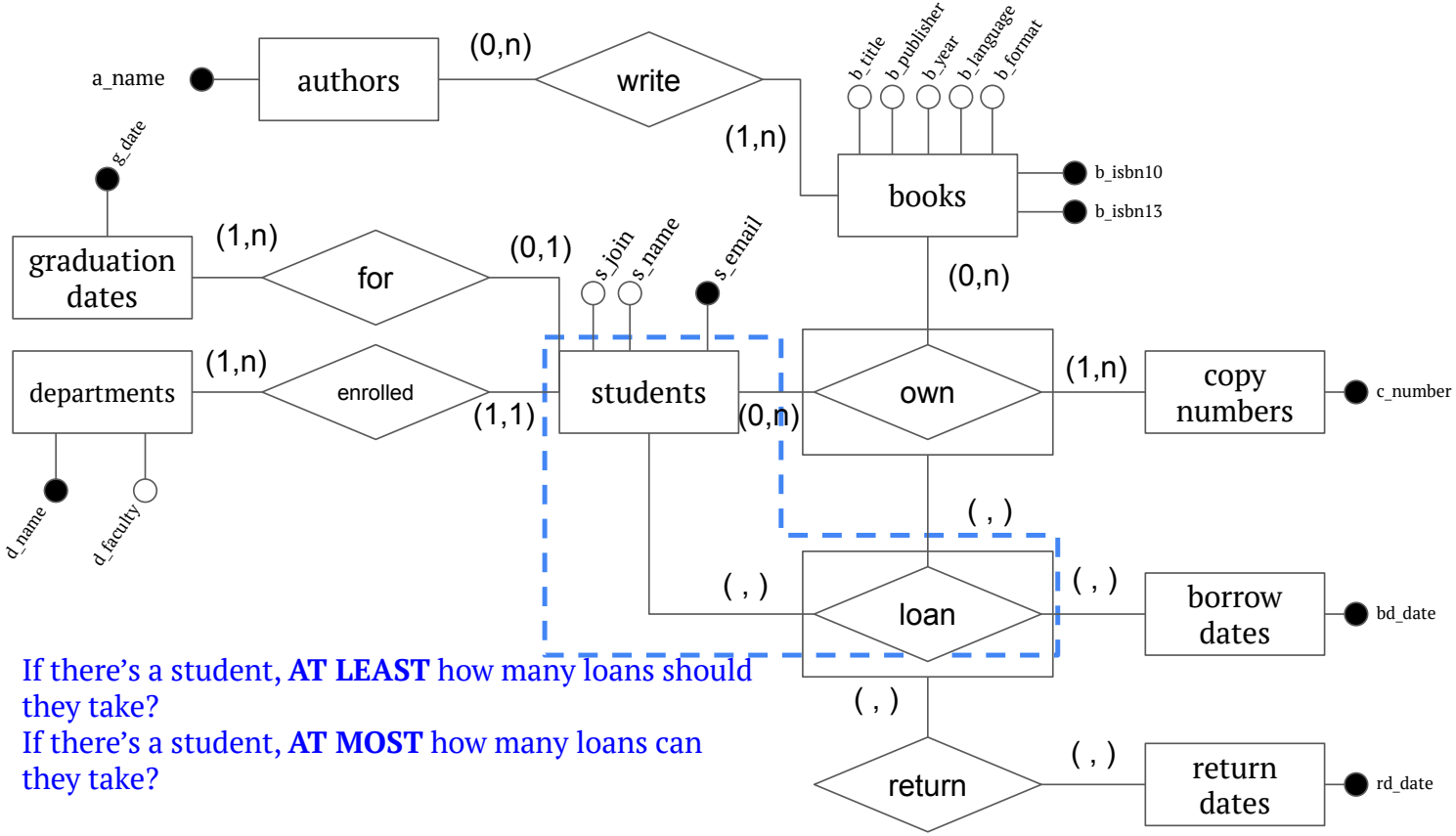
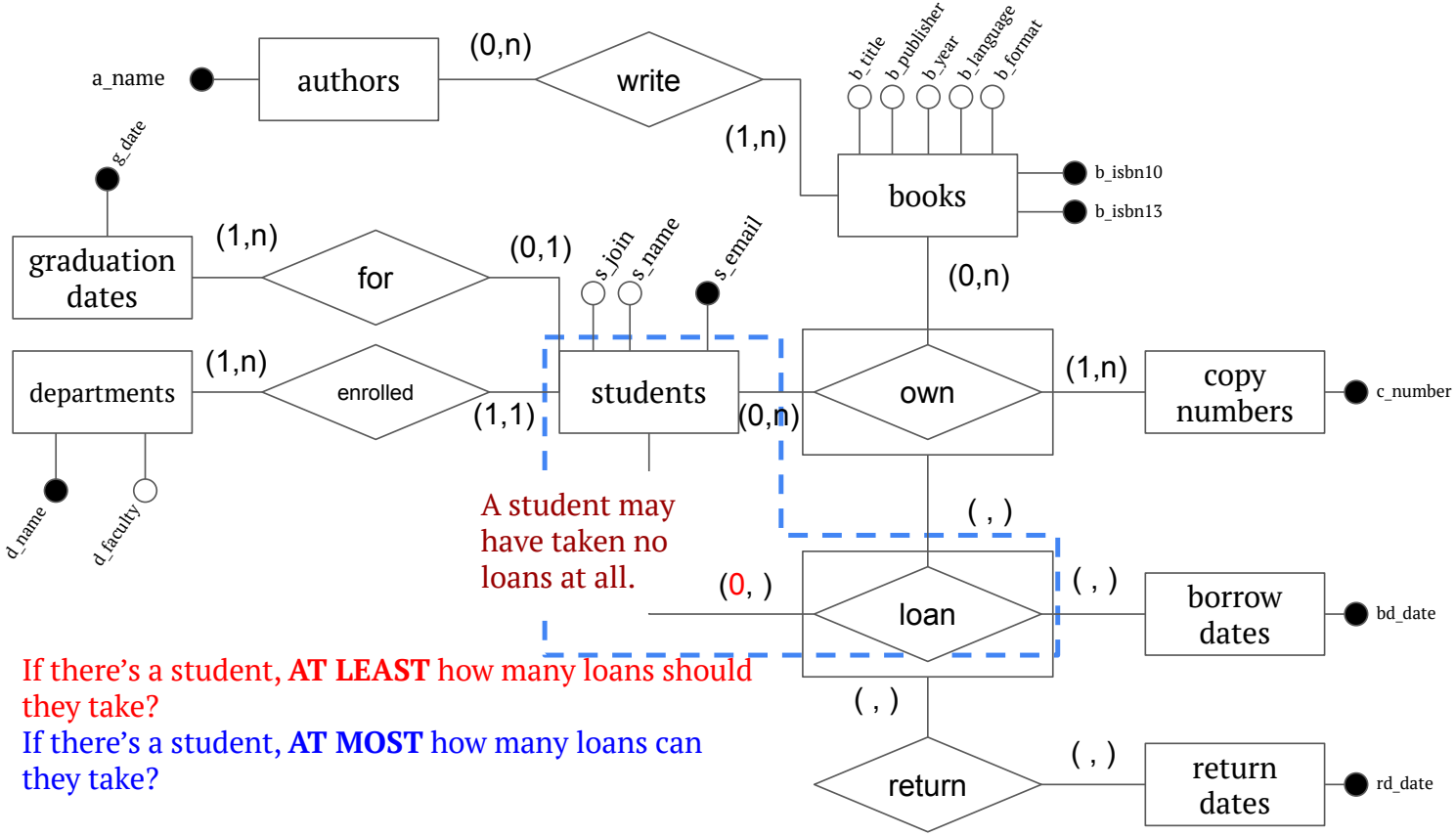


1. If there's a student, **AT LEAST** how many loans should they take?
2. If there's a student, **AT MOST** how many loans can they take?

The ER Diagram



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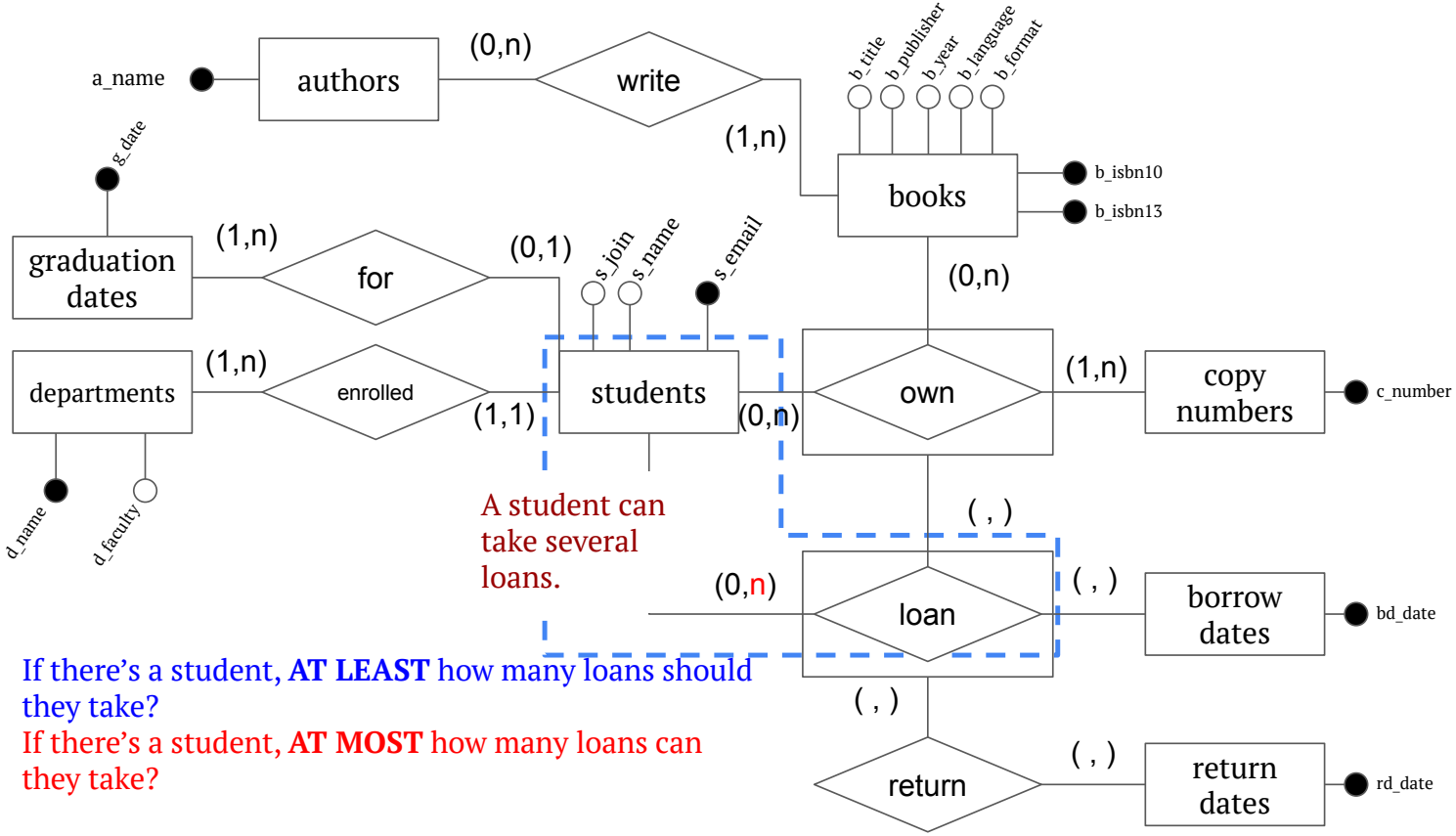

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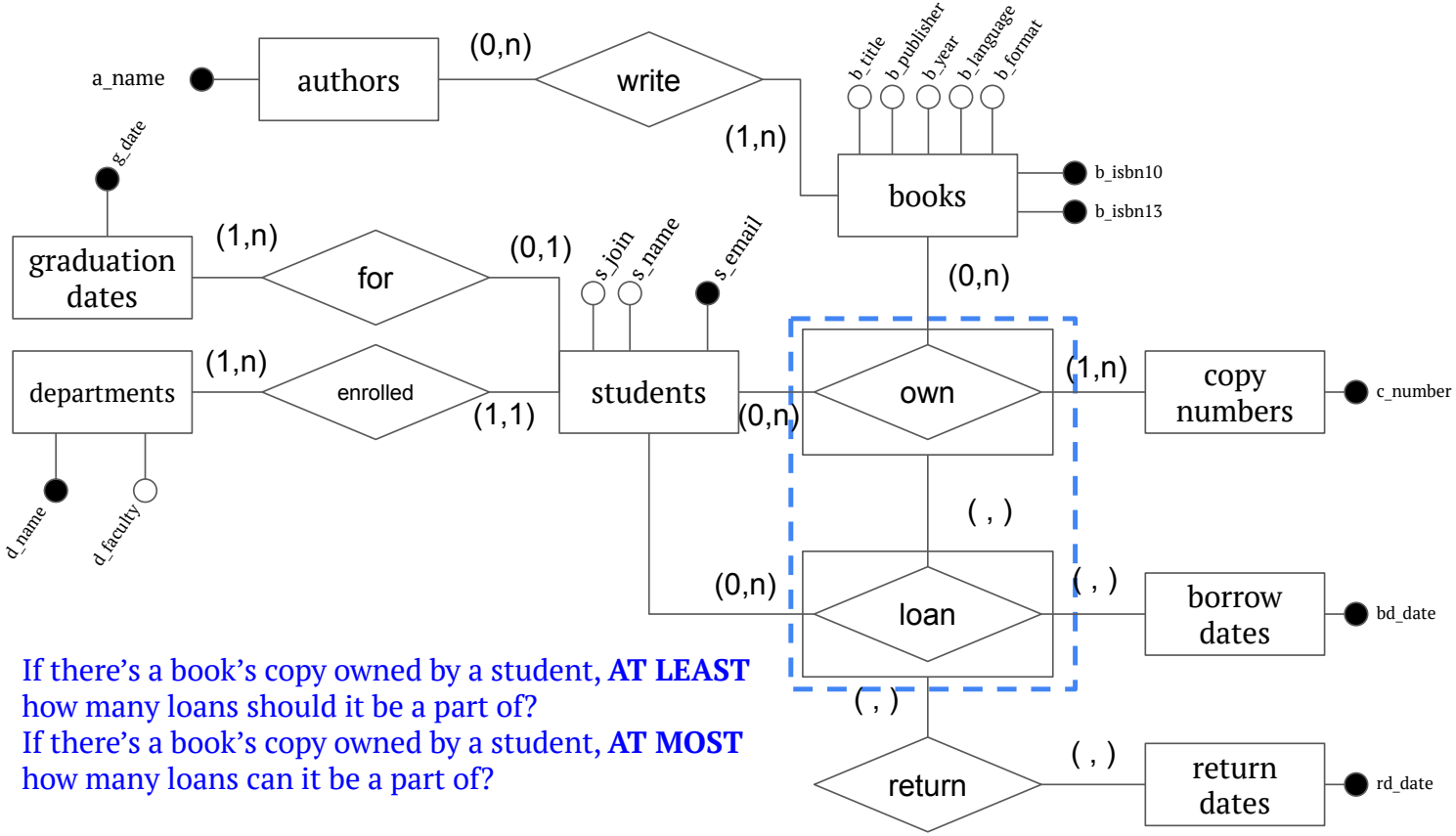
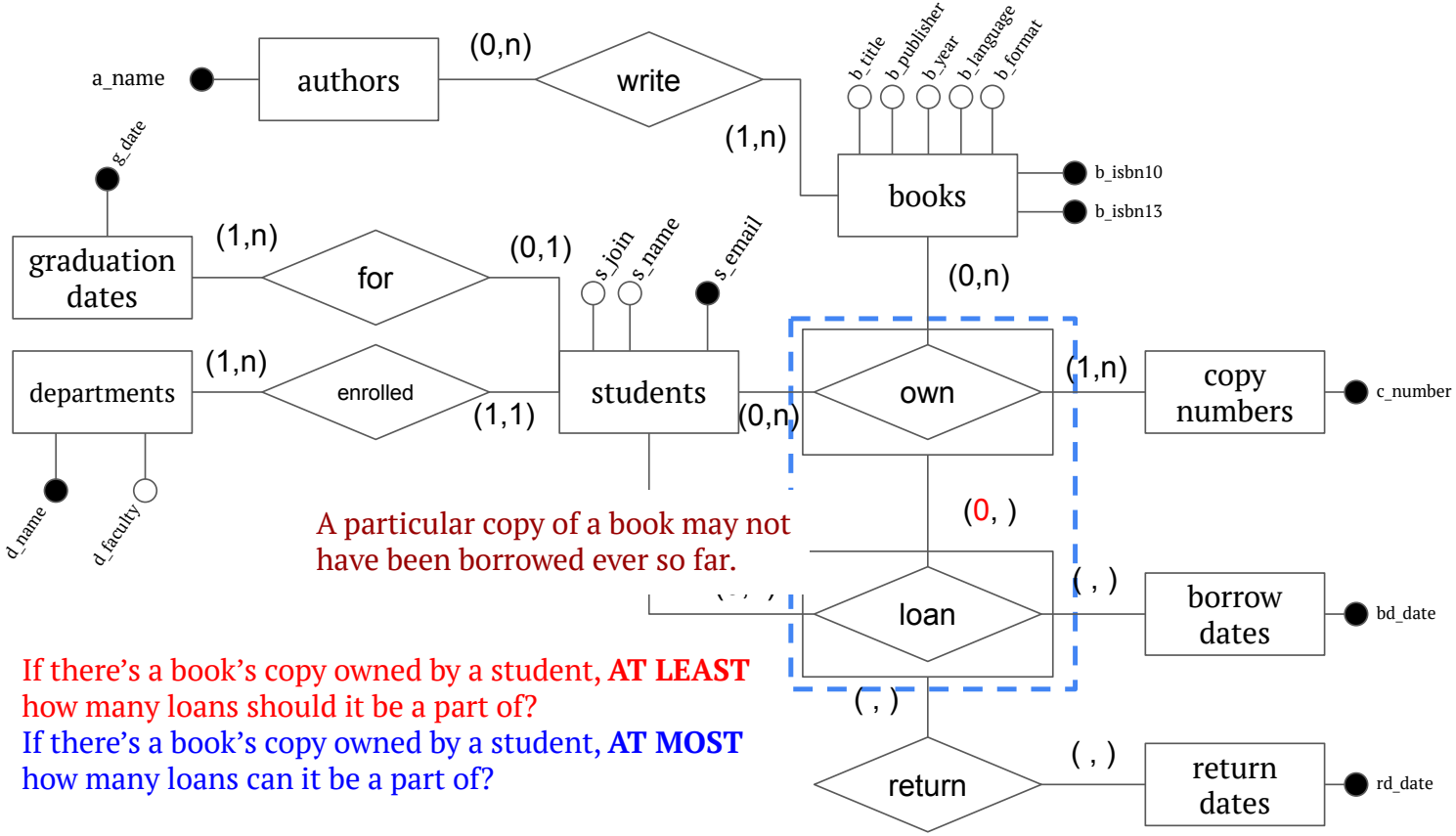


1. If there's a book's copy owned by a student, **AT LEAST** how many loans should it be a part of?
2. If there's a book's copy owned by a student, **AT MOST** how many loans can it be a part of?

The ER Diagram



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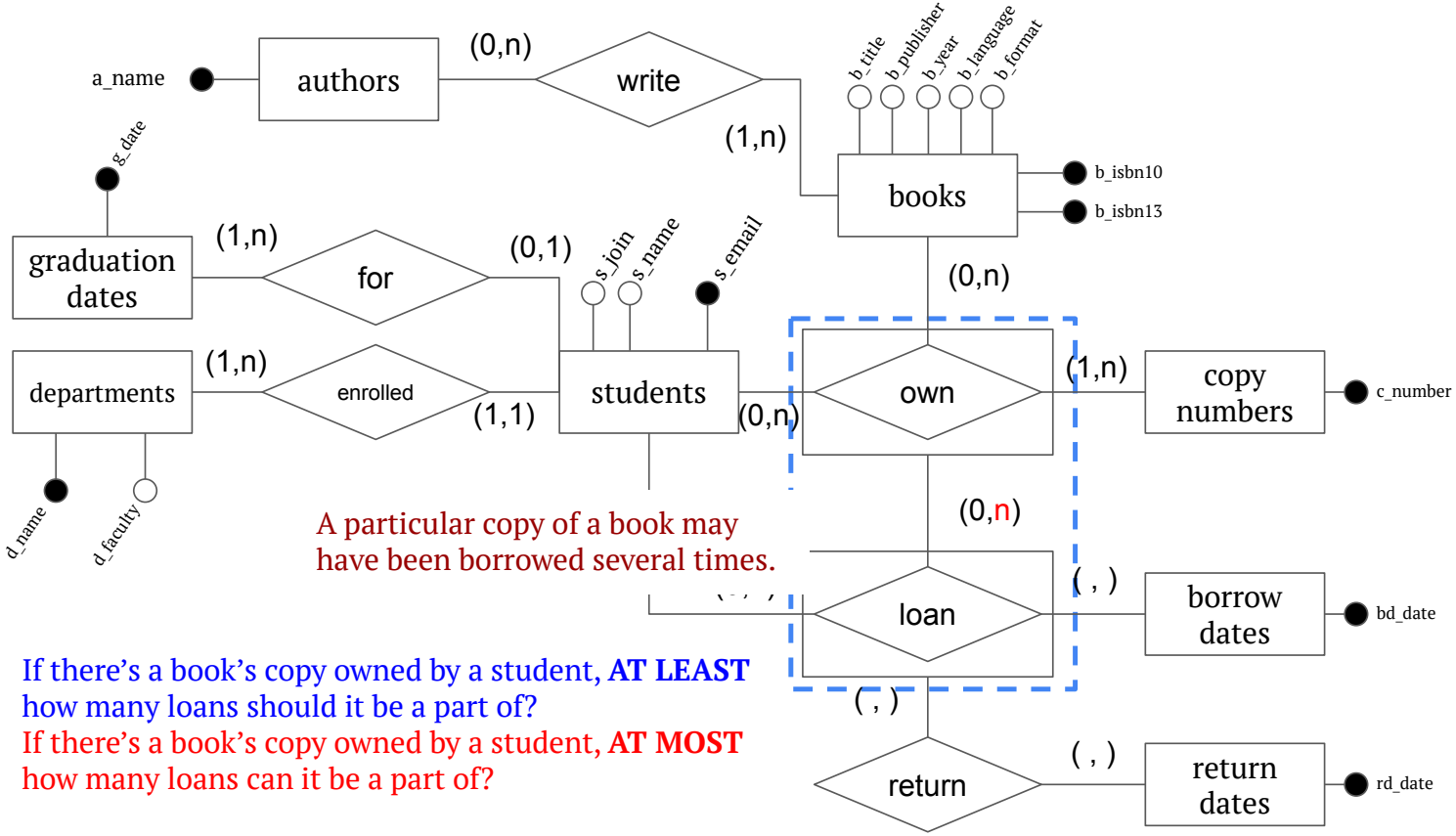

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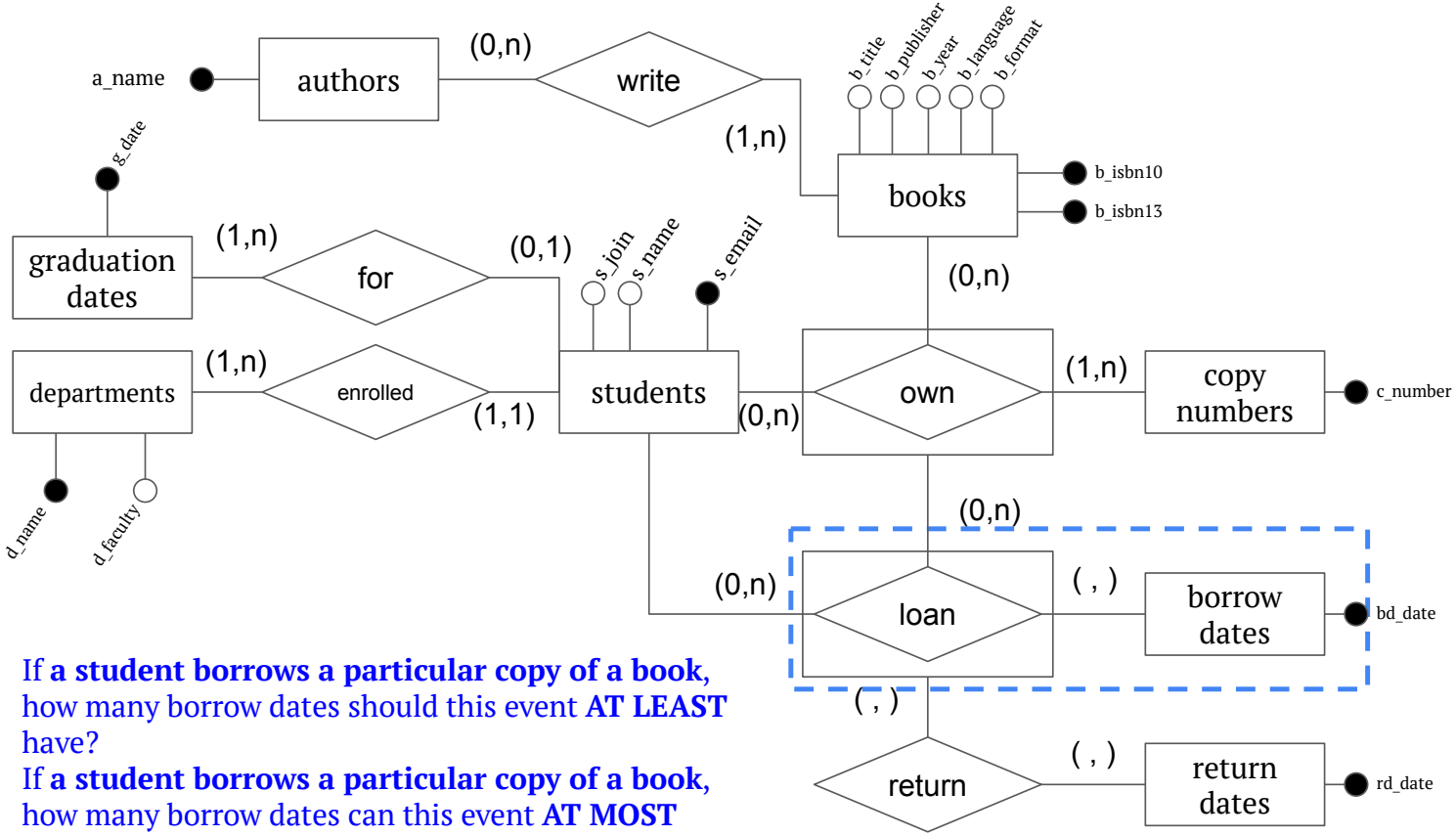
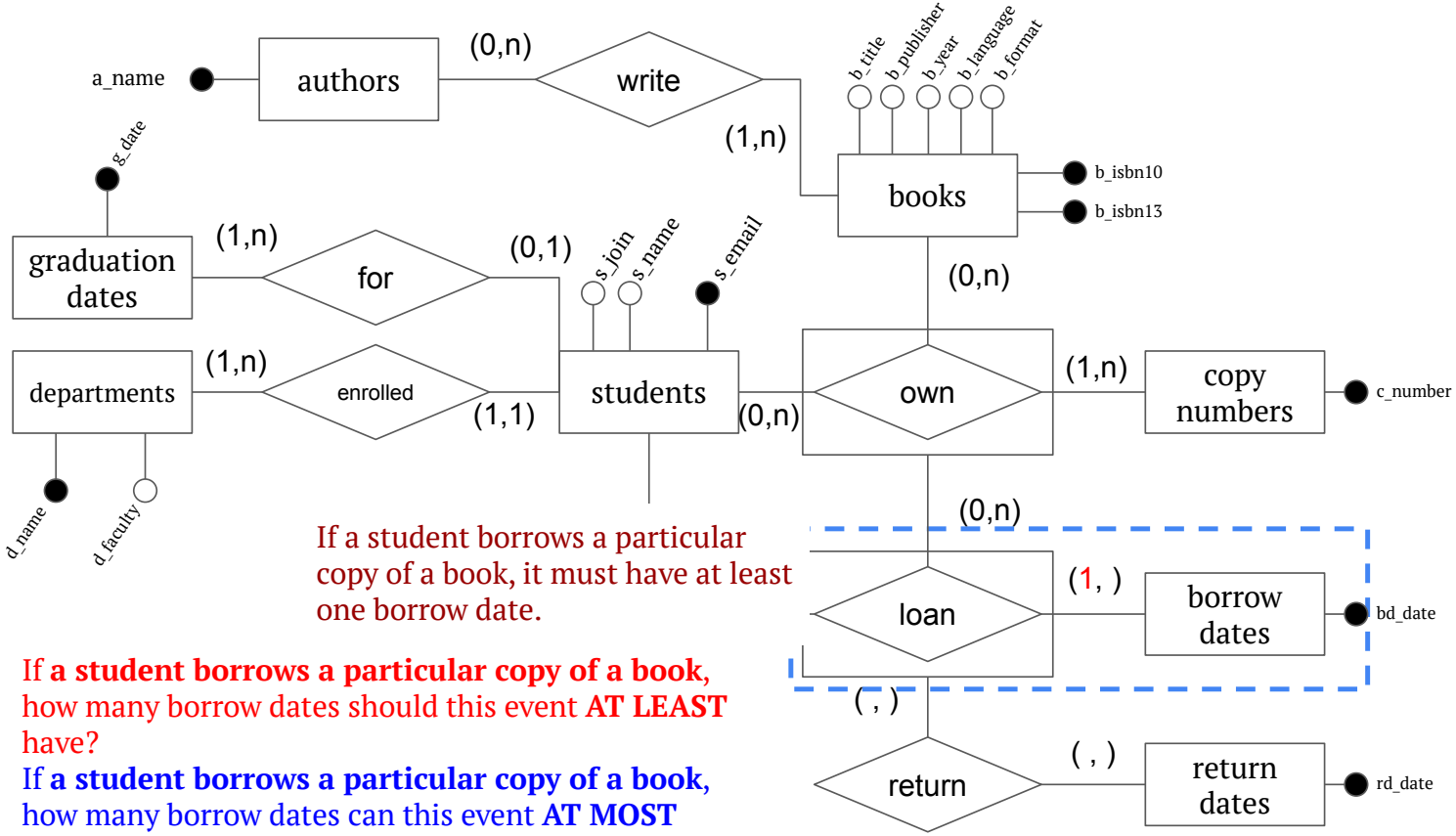


1. If **a student borrows a particular copy of a book**, how many borrow dates should this event **AT LEAST** have?
2. If **a student borrows a particular copy of a book**, how many borrow dates can this event **AT MOST** have?

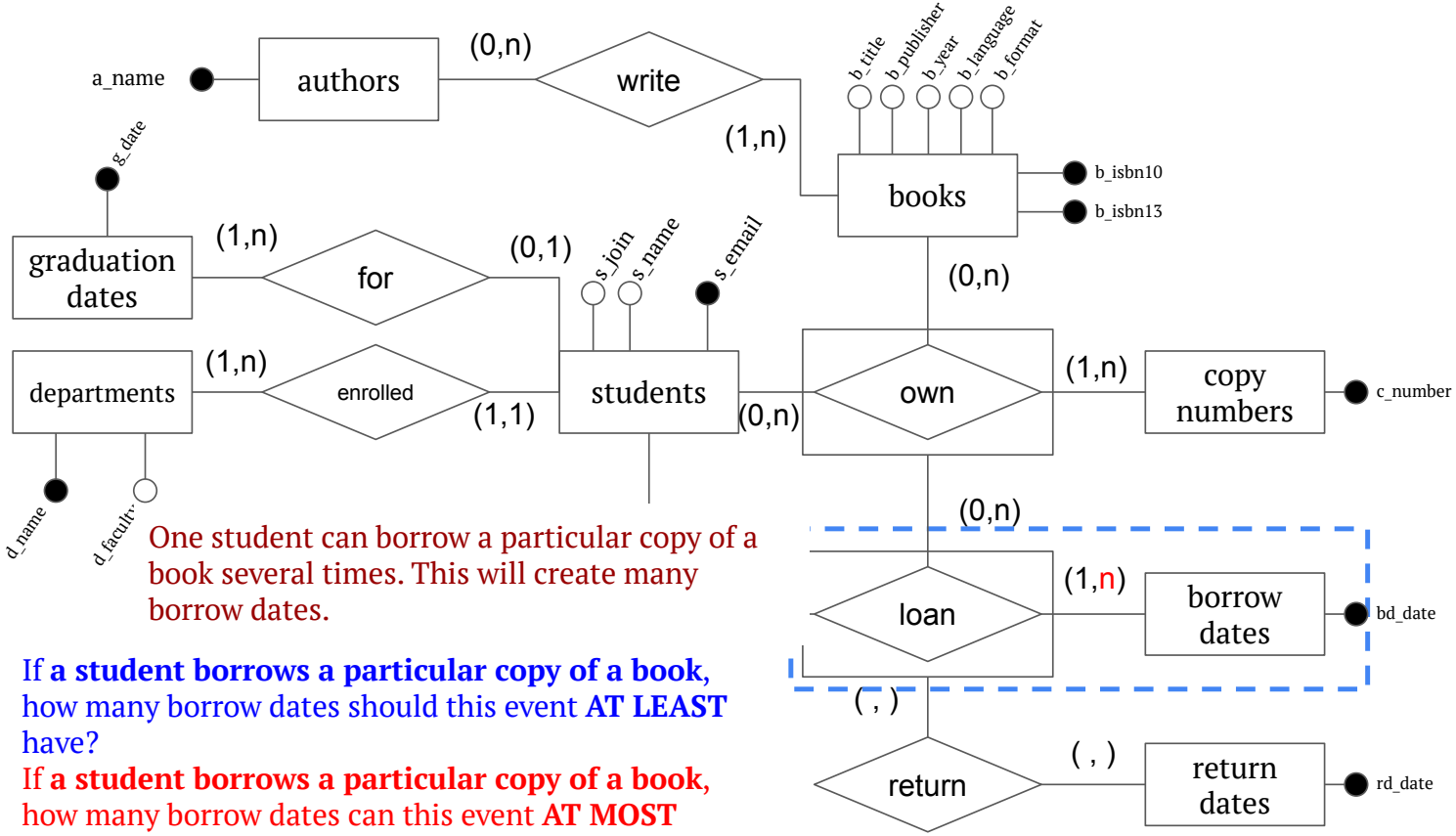
The ER Diagram



If a student borrows a particular copy of a book, it must have at least one borrow date.

1. If **a student borrows a particular copy of a book**, how many borrow dates should this event **AT LEAST** have?
2. If **a student borrows a particular copy of a book**, how many borrow dates can this event **AT MOST** have?

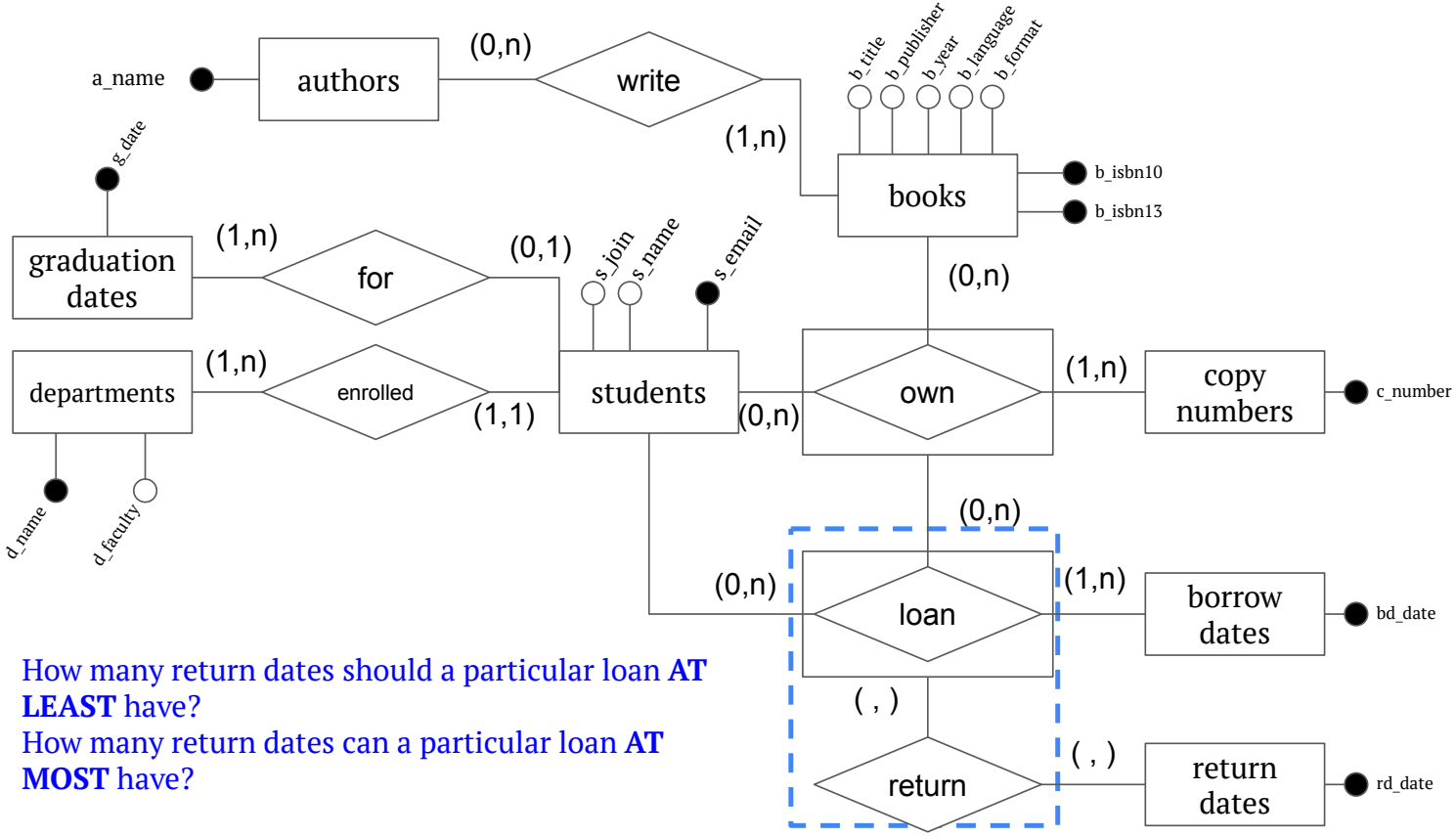
The ER Diagram



One student can borrow a particular copy of a book several times. This will create many borrow dates.

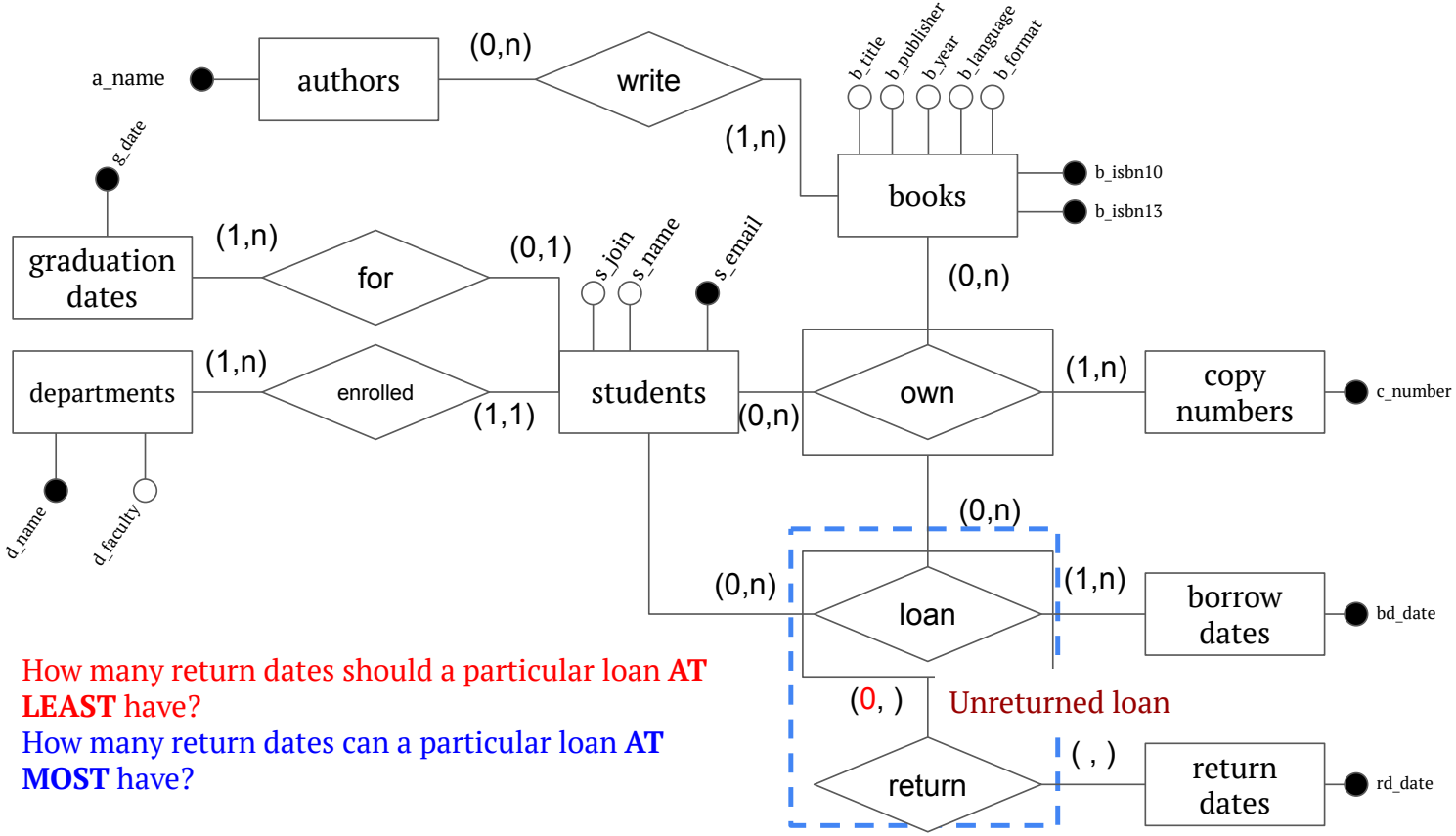
1. If **a student borrows a particular copy of a book**, how many borrow dates should this event **AT LEAST** have?
2. If **a student borrows a particular copy of a book**, how many borrow dates can this event **AT MOST** have?

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



1. How many return dates should a particular loan **AT LEAST** have?
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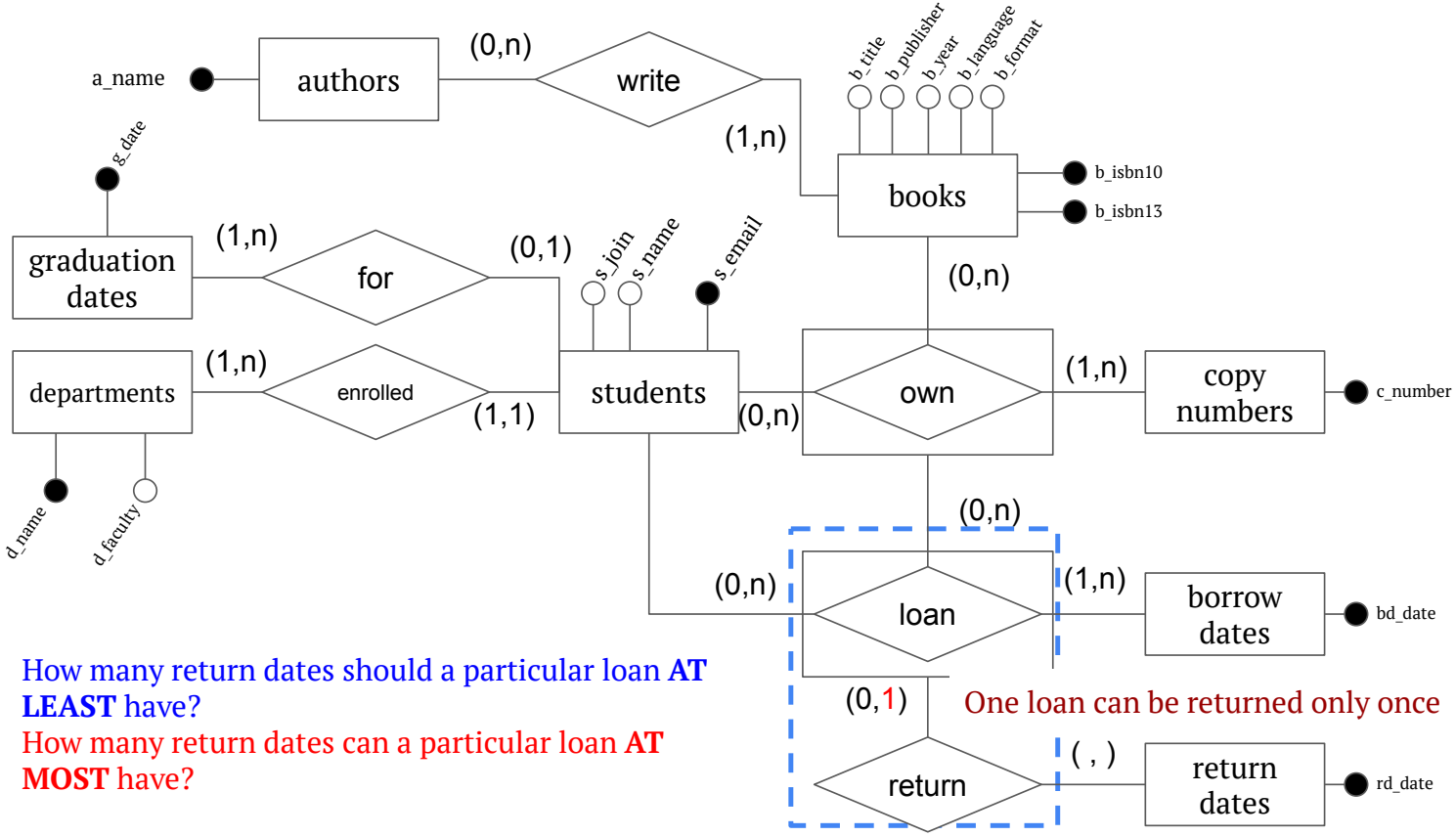
The ER Diagram



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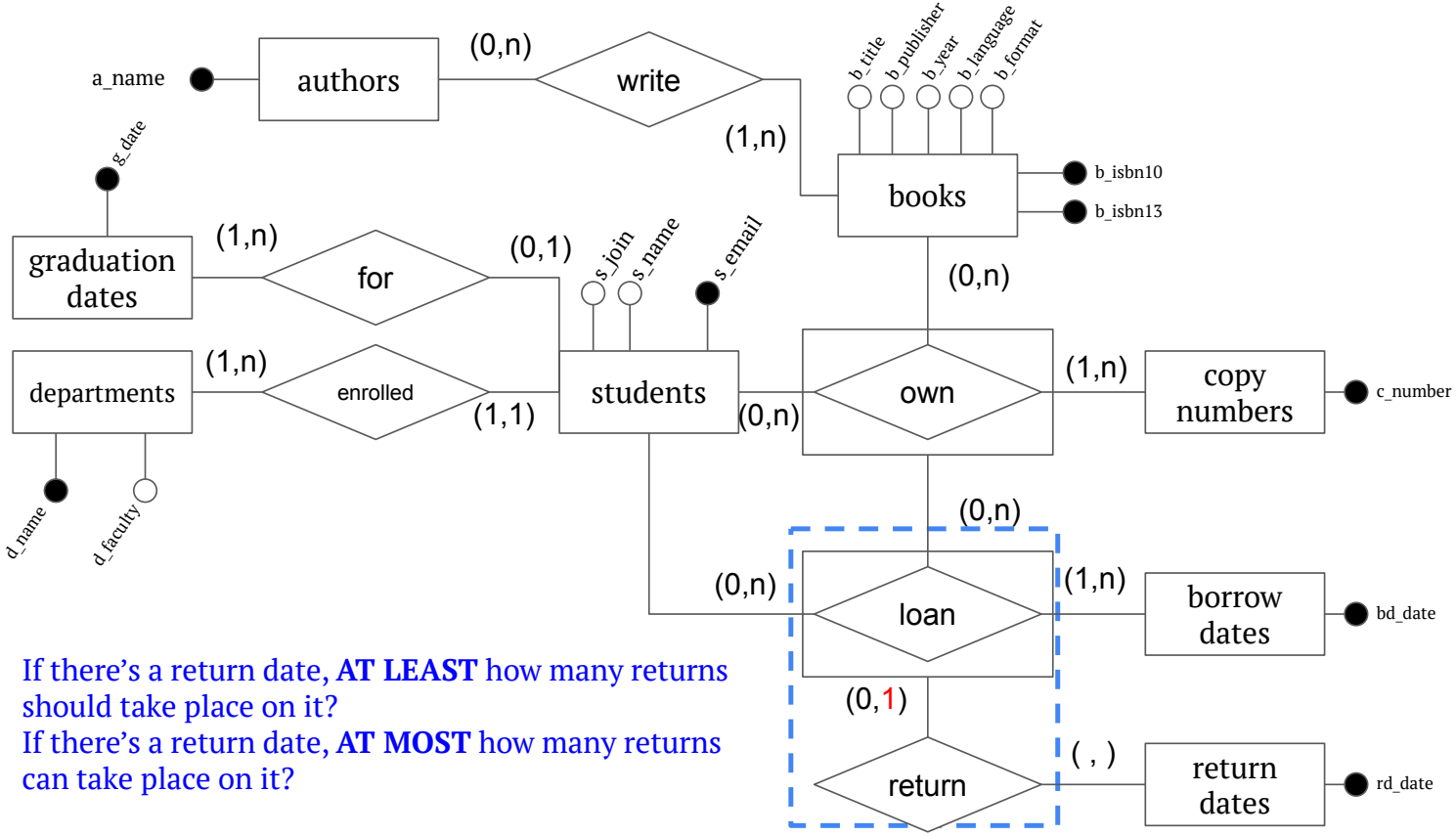
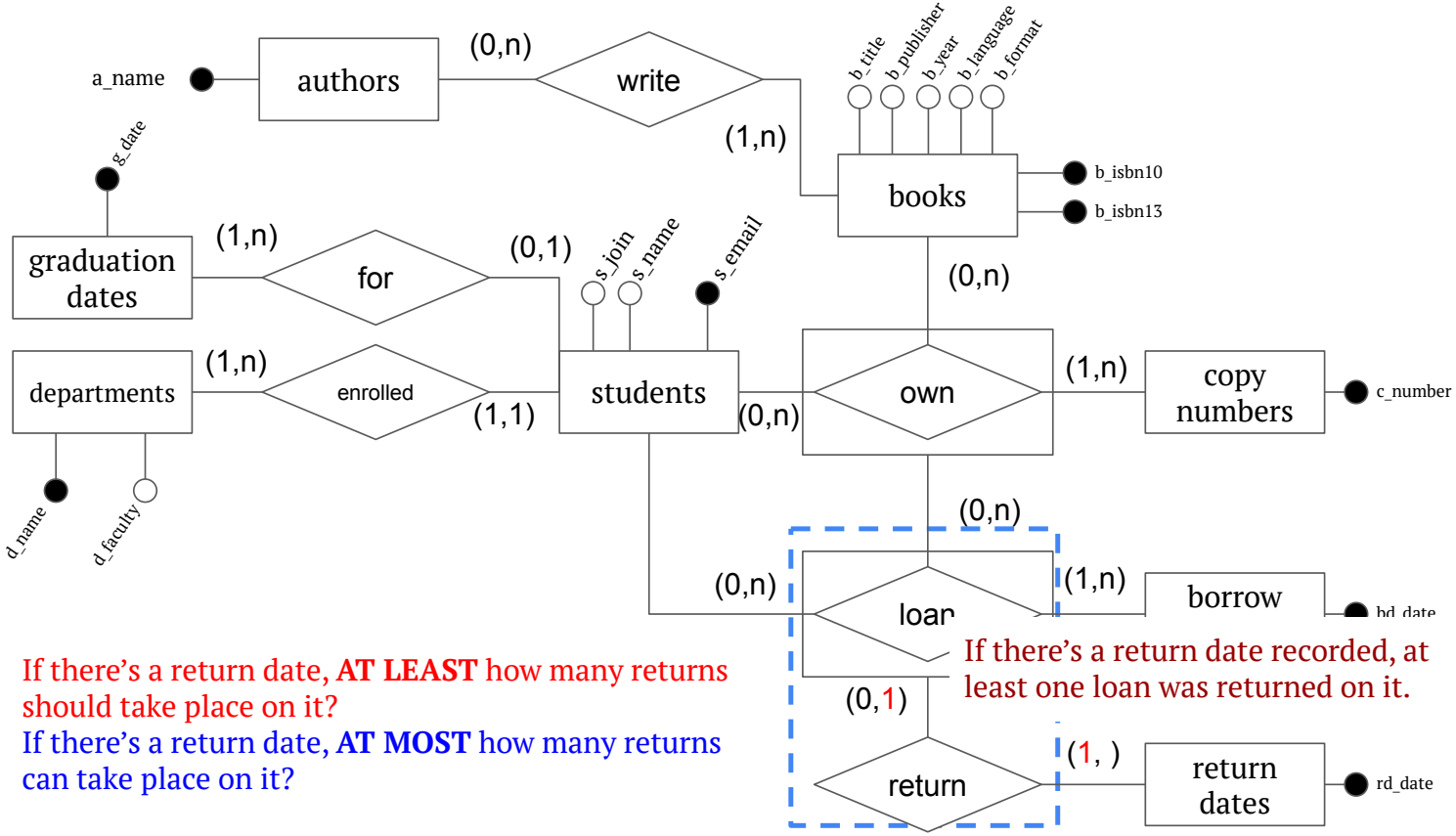
The ER Diagram



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

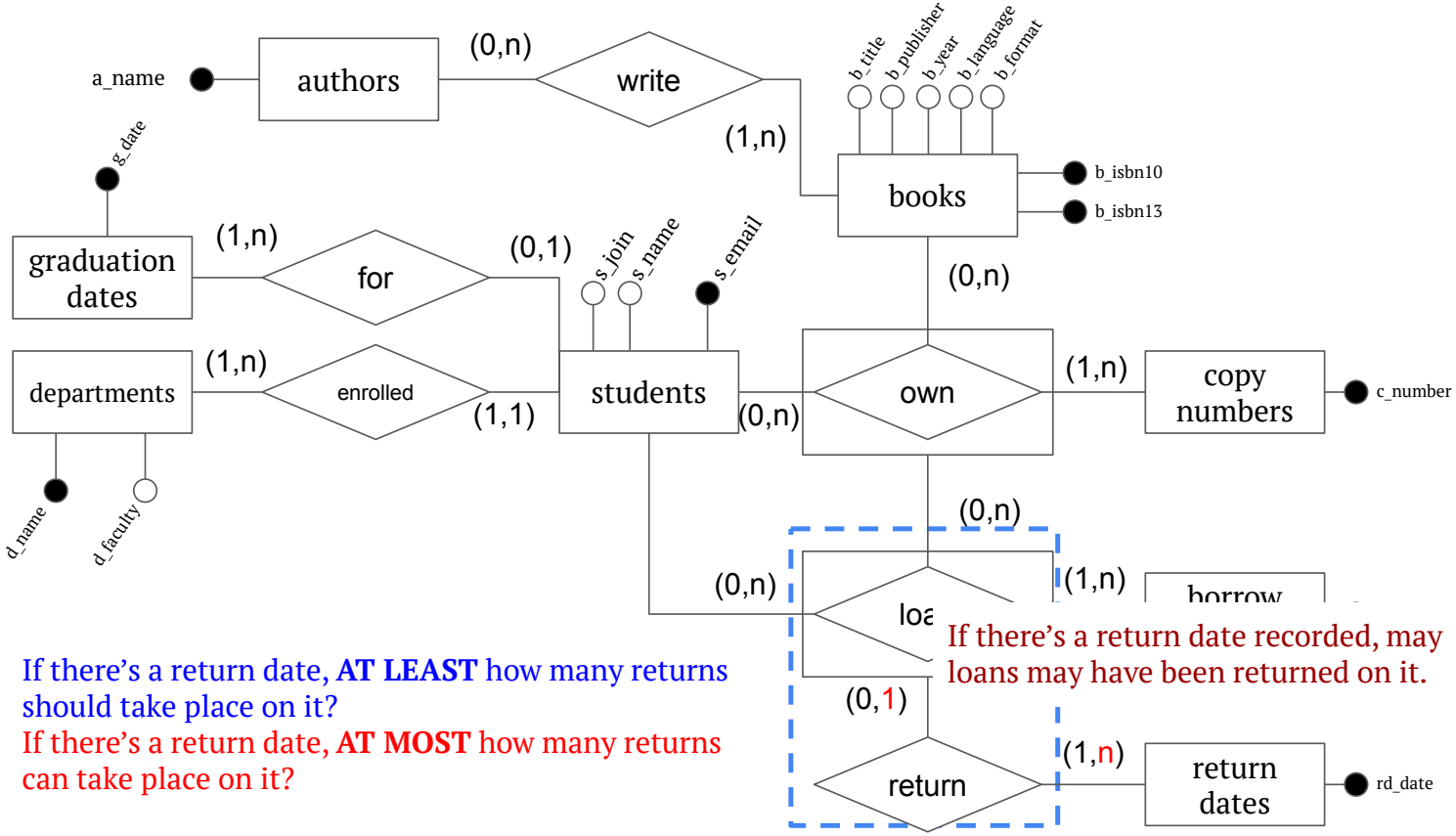
The ER Diagram



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

If there's a return date recorded, at least one loan was returned on it.

The ER Diagram



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

If there's a return date recorded, may loans may have been returned 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.

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