Entity-Relationship Data Model

Spring 2025

Thinking about data

How do we represent data?

To know how to represent data, we need to know what the data represents

- books collection for a library à la goodreads
- messages à la Slack
- customer survey responses à la Qualtrics

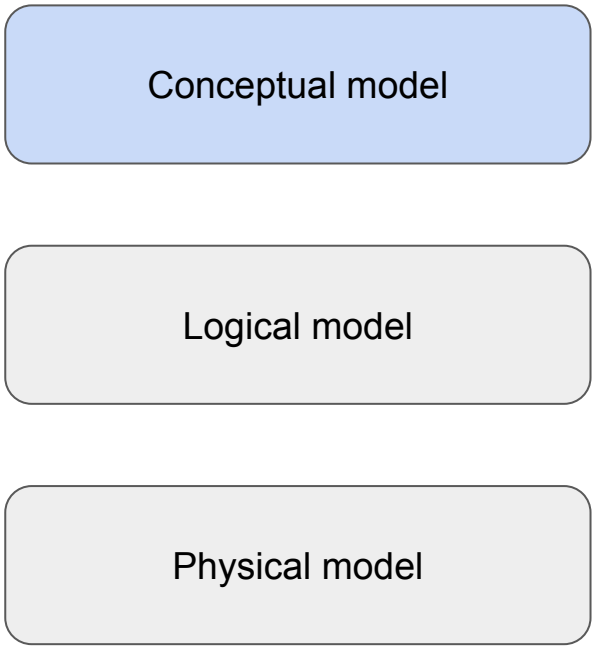
You need to understand the data to know what it represents

- we model the data to understand it

Thinking about data

Conceptual model	What is the data about?
Logical model	How does the data fit within a database model?
Physical model	How is the data represented in memory or on disk?

Thinking about data



What is the data about?

How does the data fit within a database model?

How is the data represented in memory or on disk?

The entity-relationship data model

The entity-relationship (ER) data model

- Chen (1976)
- human-centric model to help understand the data

The ER model is never implemented directly

- it is a thinking (and communicating) guide

We'll use the Chen notation, but notation is not what is important

- it's the exercise of working through the model that is important

Entities

An entity is a "thing" that can be distinguished from other "things"

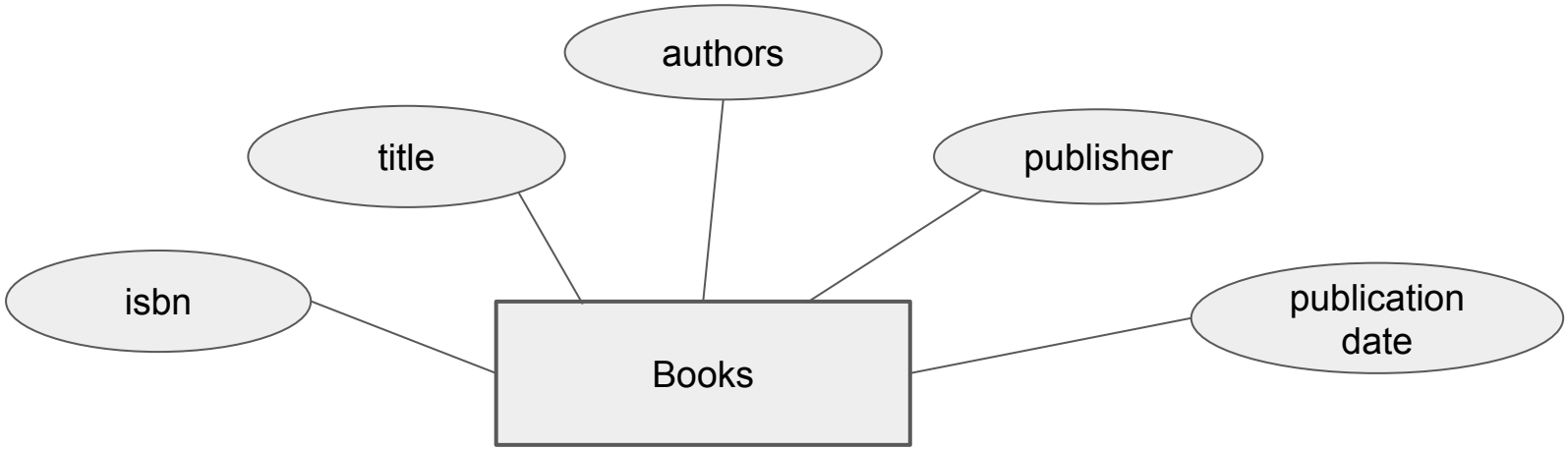
- an entity is described by attributes
- an attribute takes a value out of some domain of values

An entity set is a collection of similar entities (same set of attributes)

Entity set **Books:**

- title
- isbn
- page count
- publication date
- authors
- …

Example



Keys

Sets of attributes used to uniquely identify an entity in an entity set

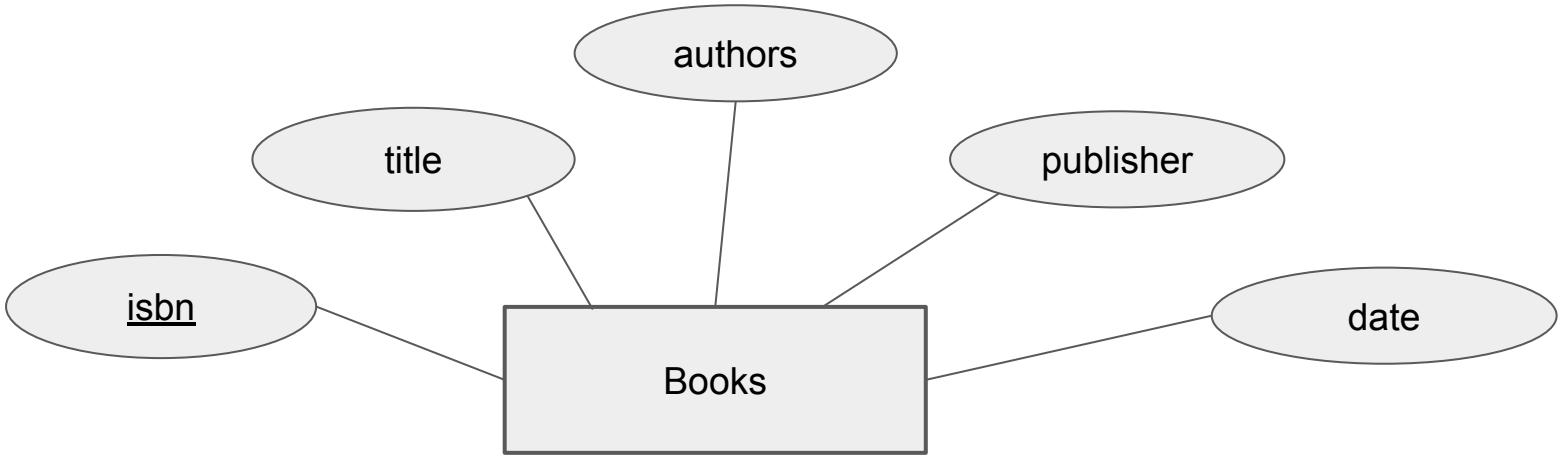
Superkey: one or more attributes that together uniquely identify an entity

- all attributes together should be a superkey
- if not, you can't distinguish repetitions

Candidate key: a minimal superkey

Primary key: a candidate key **chosen** to identify entities

Example



Relationships

A relationship is an association between two or more entities

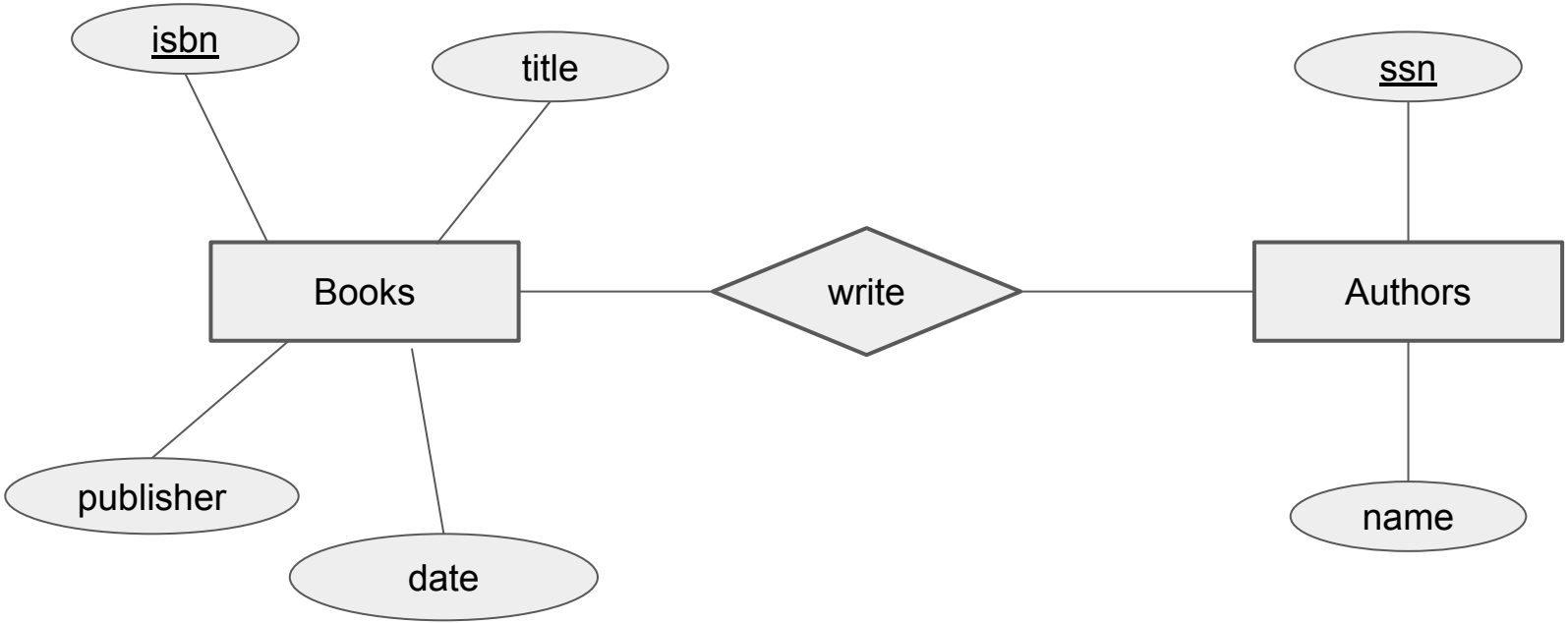
- an **author** writes a **book**

A relationship set is a collection of similar relationships

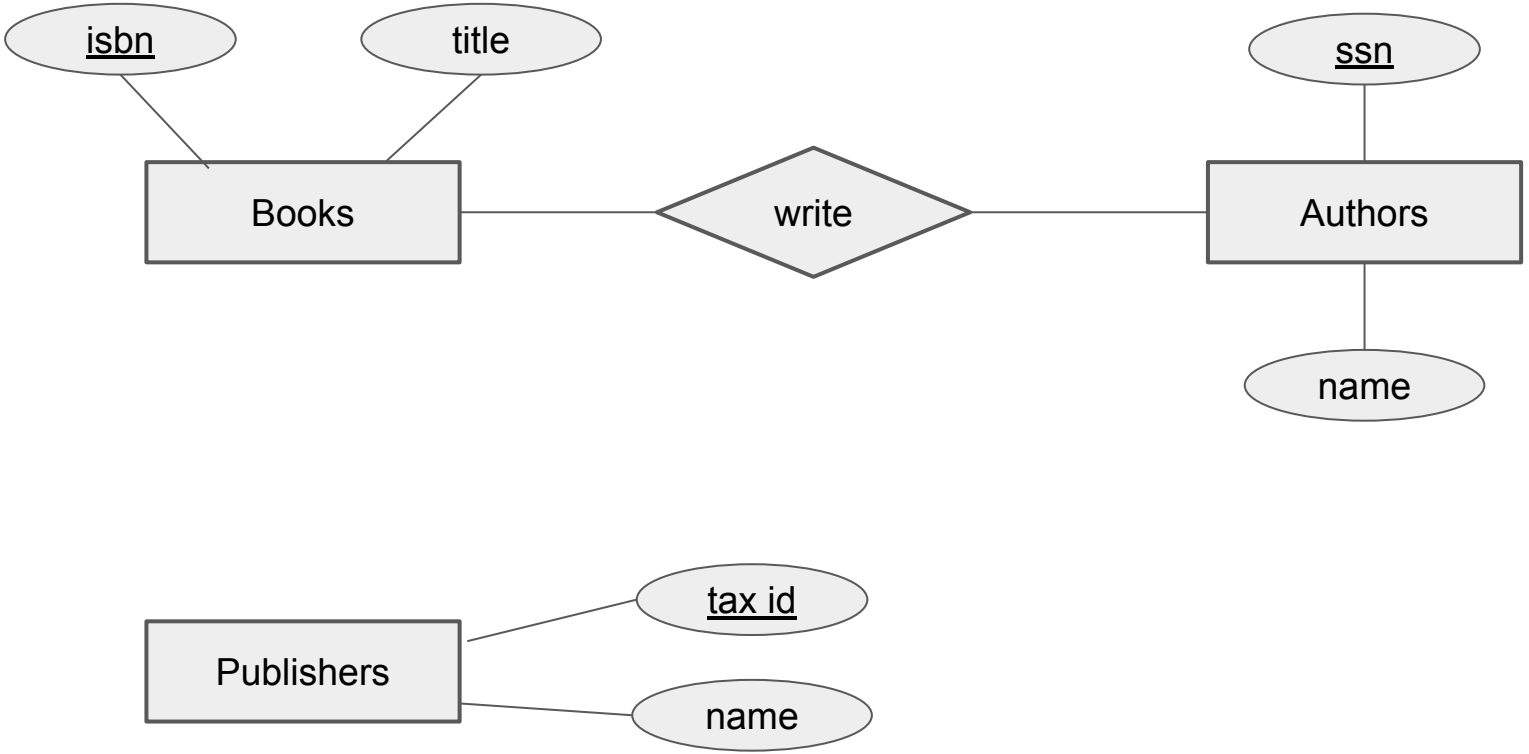
Write is a relationship between **Books** and an **Authors**

- relationships can have attributes
- if the same entity set appears multiple times in a relationship, can distinguish using *roles*

Example



Example


isbn
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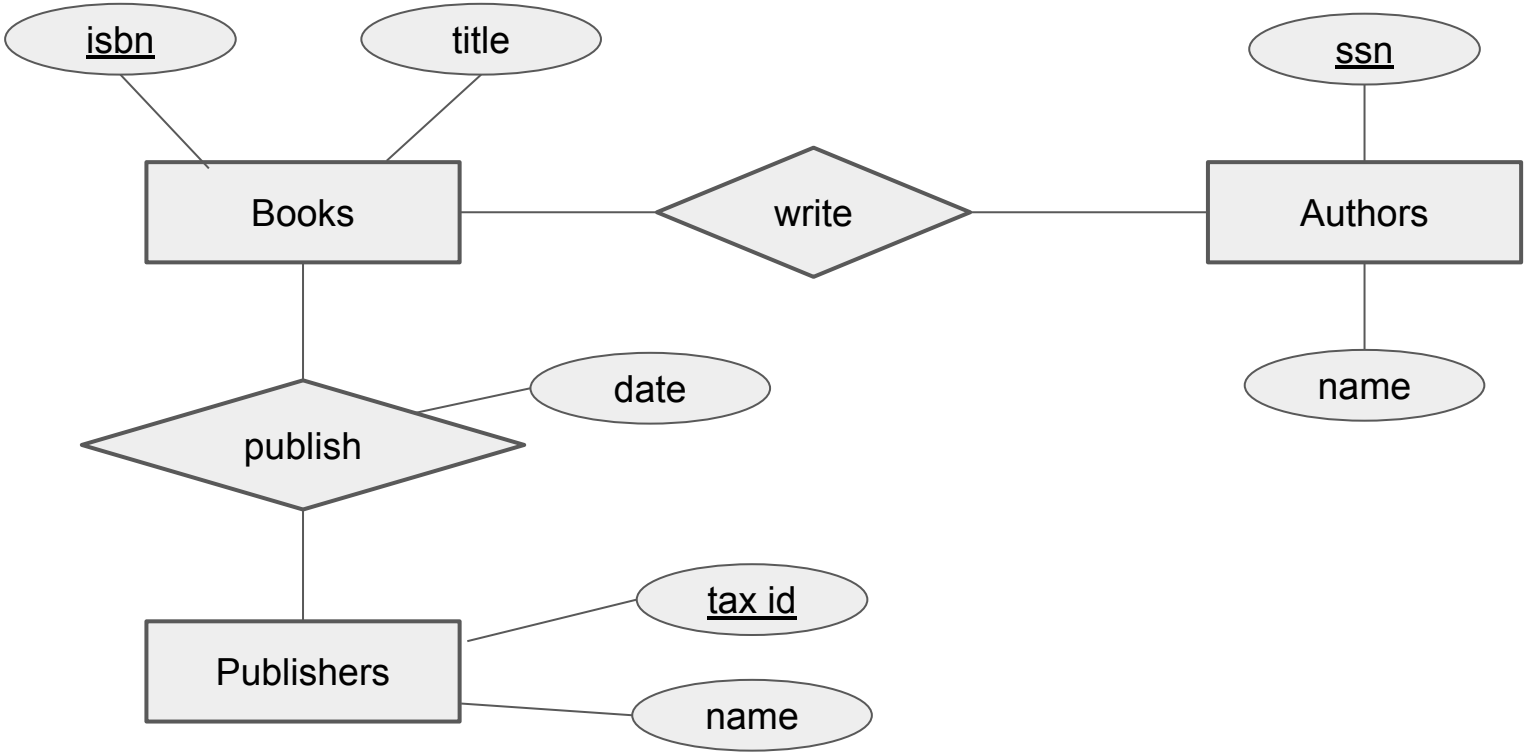
Example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Key (cardinality) constraints

How many relationships can an entity participate in?

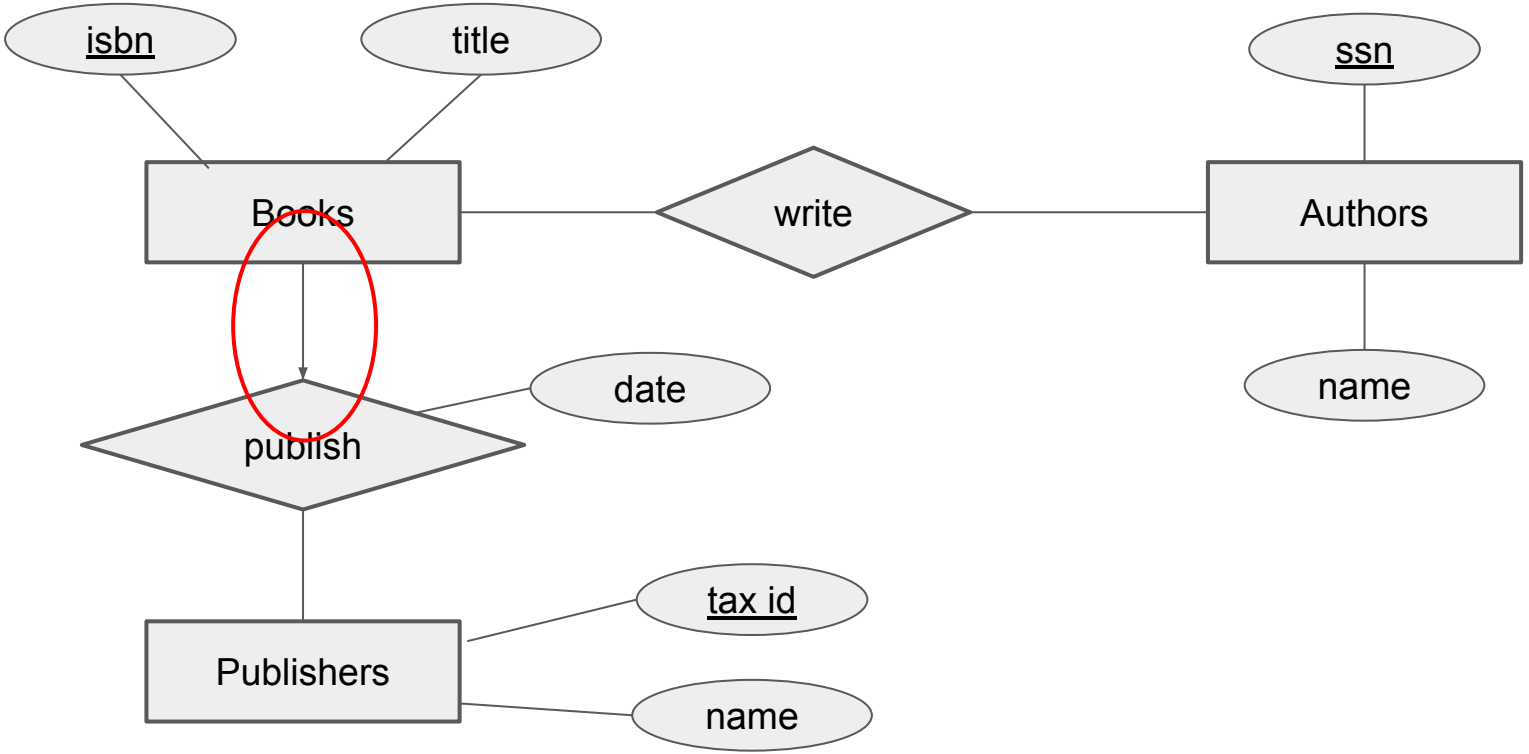
Examples:

- a book may have multiple authors, but a single publisher
- a book review applies to one book and is written by one reviewer

Annotate the relationship with cardinality constraints

- **1** or **N** ("many") on an entity line says how many relationships it participates in
- alternatively, use ← instead of **1** and — instead of **N**
- we talk of **1**:**1** or **1**:**N** or **N**:**1** or **N**:**N** relationship sets
- most DBs can enforce cardinality constraints

Example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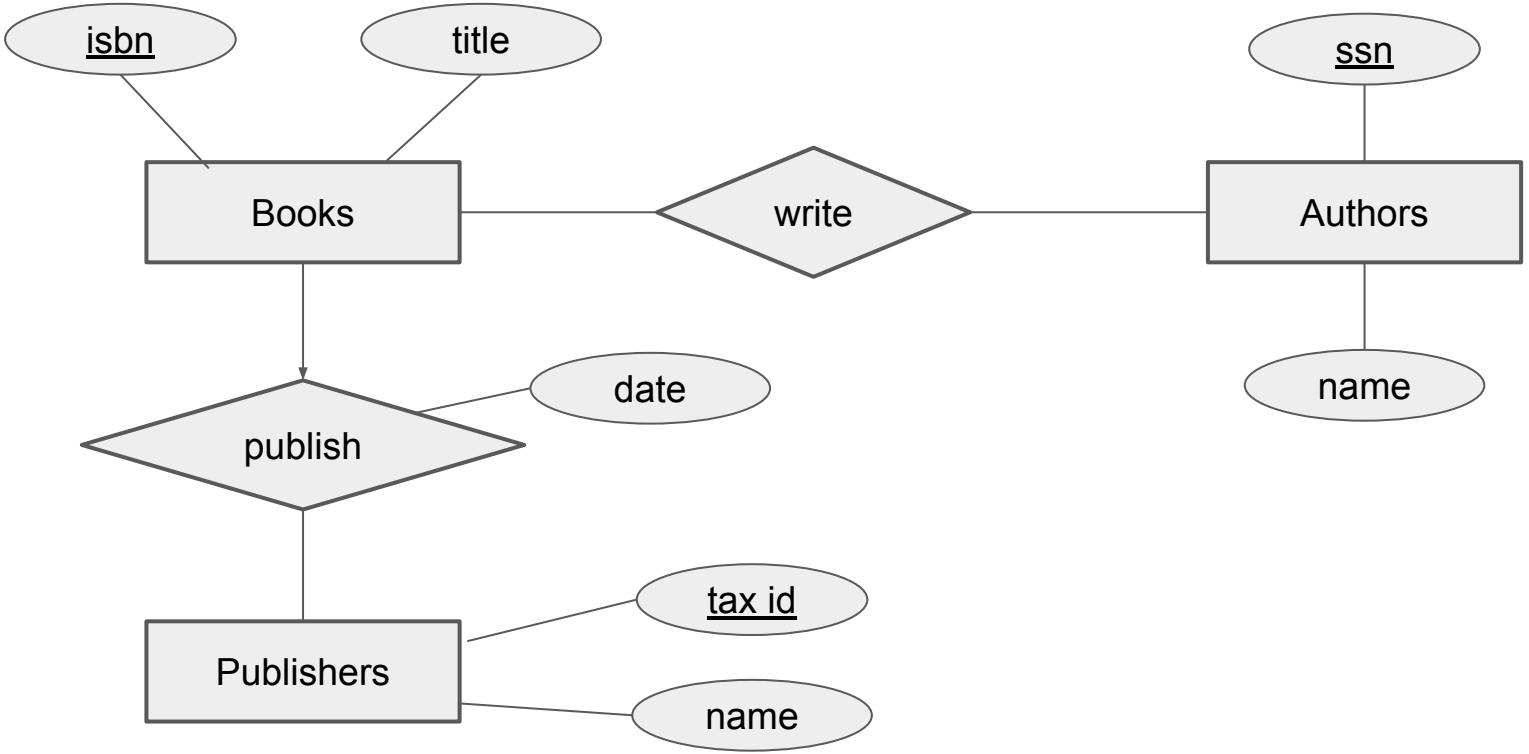
Example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Participation constraints

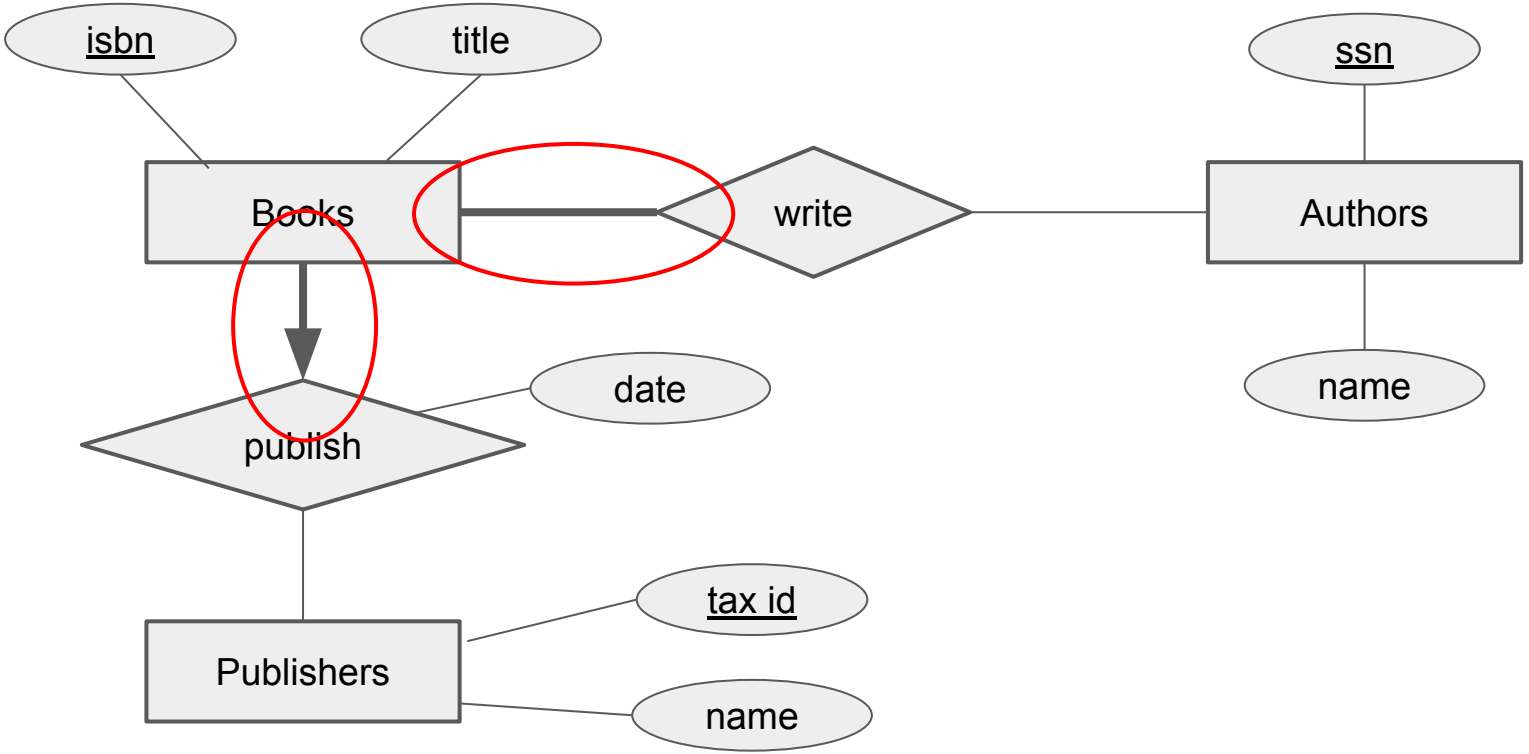
Must an entity participate in a relationship?

- a book must have at least one author
- an author need to not have written any book (yet)

Annotate the relationship with participation constraints

- Use **0** on the entity line to indicate optional participation
- Compatible with **1** (exactly 1) and **N** (one or more)
- alternatively, use — instead of **0** and **—** instead of **1** or **N**
- most DBs can enforce participation constraints (useful, errors if they fail)

Example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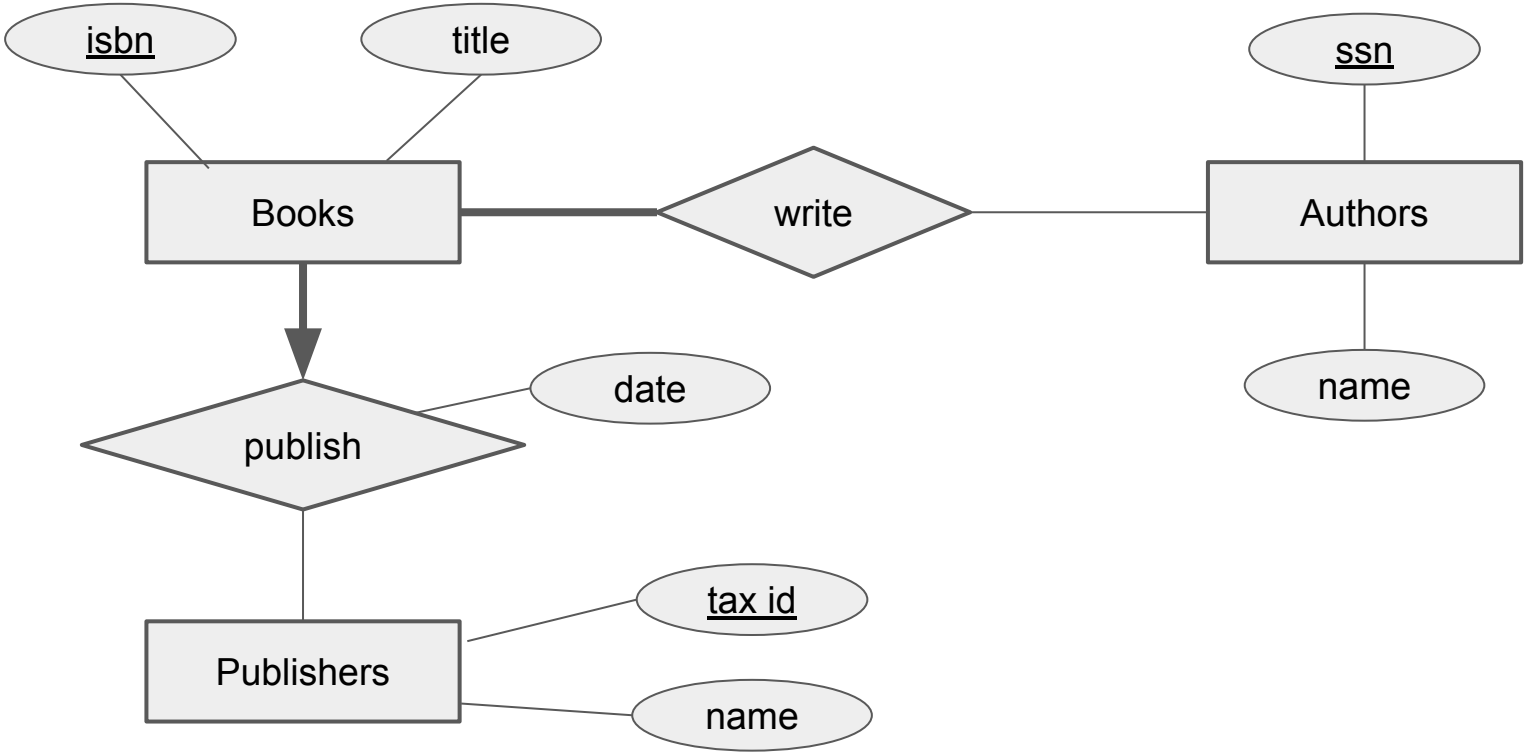
Example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Ternary relationships

Examples of relationships have been binary — relating two entities

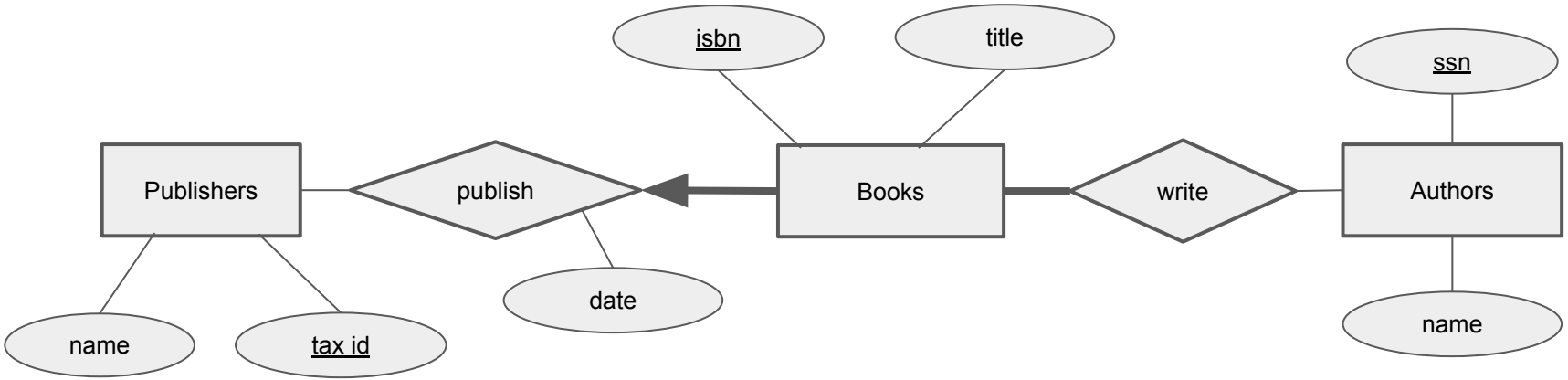
This obviously generalizes:

A **distributor** distributes a **book** in a **region**

- A distributor may distribute different books in different regions
- A region may have different distributors distributing different books
- A book may be distributed by different distributors in different regions

This is a ternary relationship

Example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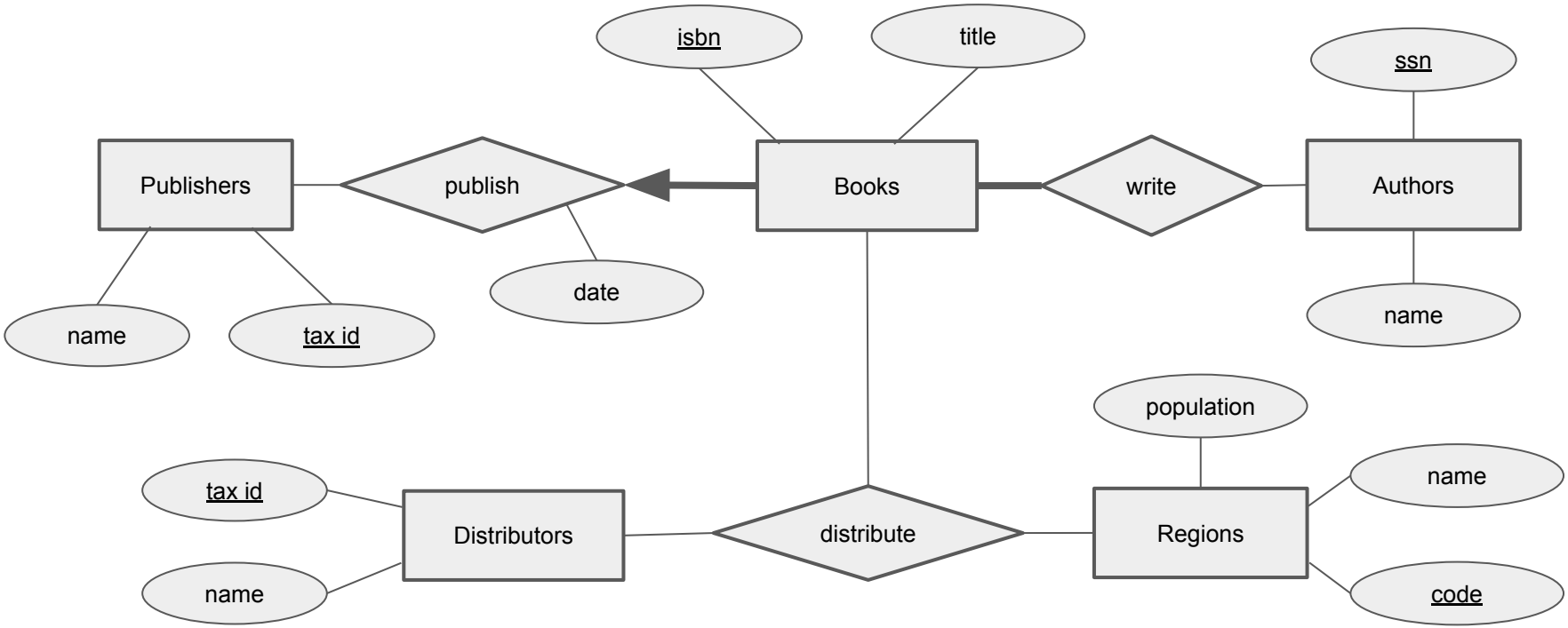
Example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Distributors
distribute
Regions
name
name
code

Other examples

Qualtrics-like surveys

Slack-like messaging

Appendix: relationship keys

We can identify a relationship by the primary key of the entities in the relationship

You can define the primary key of a relationship set A — R — B if you have cardinality constraints on R

- **N**:**N** primary(R) = primary(A) ∪ primary(B)
- **1**:**N** primary(R) = primary(B)
- **N**:**1** primary(R) = primary(A)
- **1**:**1** primary(R) = primary(A) or primary(B)