

- 6.15** Construct an E-R diagram for a hospital with a set of patients and a set of medical doctors. Associate with each patient a log of the various tests and examinations conducted.
- 6.16** Extend the E-R diagram of Exercise 6.3 to track the same information for all teams in a league.
- 6.17** Explain the difference between a weak and a strong entity set.
- 6.18** Consider two entity sets A and B that both have the attribute X (among others whose names are not relevant to this question).
- If the two X s are completely unrelated, how should the design be improved?
 - If the two X s represent the same property and it is one that applies both to A and to B , how should the design be improved? Consider three subcases:
 - X is the primary key for A but not B
 - X is the primary key for both A and B
 - X is not the primary key for A nor for B
- 6.19** We can convert any weak entity set to a strong entity set by simply adding appropriate attributes. Why, then, do we have weak entity sets?
- 6.20** Construct appropriate relation schemas for each of the E-R diagrams in:
- Exercise 6.1.
 - Exercise 6.2.
 - Exercise 6.3.
 - Exercise 6.15.
- 6.21** Consider the E-R diagram in Figure 6.30, which models an online bookstore.
- Suppose the bookstore adds Blu-ray discs and downloadable video to its collection. The same item may be present in one or both formats, with differing prices. Draw the part of the E-R diagram that models this addition, showing just the parts related to video.
 - Now extend the full E-R diagram to model the case where a shopping basket may contain any combination of books, Blu-ray discs, or downloadable video.
- 6.22** Design a database for an automobile company to provide to its dealers to assist them in maintaining customer records and dealer inventory and to assist sales staff in ordering cars.

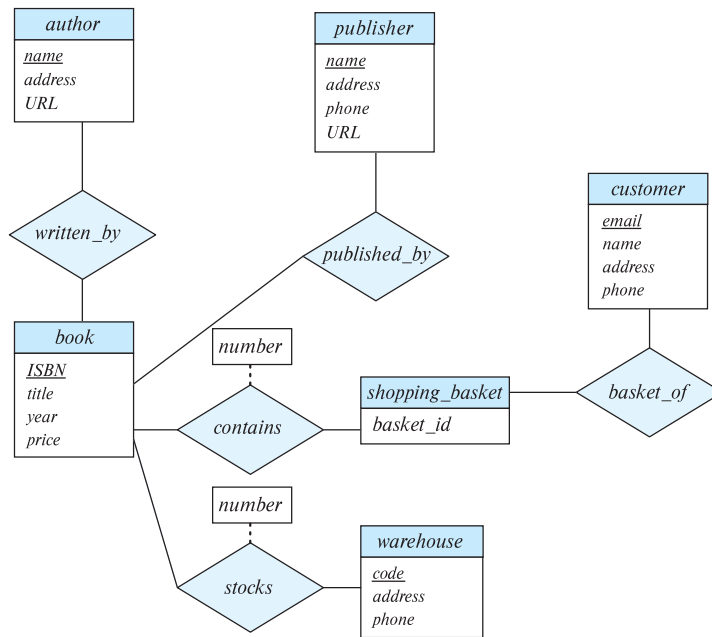


Figure 6.30 E-R diagram for modeling an online bookstore.

Each vehicle is identified by a vehicle identification number (VIN). Each individual vehicle is a particular model of a particular brand offered by the company (e.g., the XF is a model of the car brand Jaguar of Tata Motors). Each model can be offered with a variety of options, but an individual car may have only some (or none) of the available options. The database needs to store information about models, brands, and options, as well as information about individual dealers, customers, and cars.

Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

- 6.23** Design a database for a worldwide package delivery company (e.g., DHL or FedEx). The database must be able to keep track of customers who ship items and customers who receive items; some customers may do both. Each package must be identifiable and trackable, so the database must be able to store the location of the package and its history of locations. Locations include trucks, planes, airports, and warehouses.

Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

- 6.24** Design a database for an airline. The database must keep track of customers and their reservations, flights and their status, seat assignments on individual flights, and the schedule and routing of future flights.

Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

- 6.25** In Section 6.9.4, we represented a ternary relationship (repeated in Figure 6.29a) using binary relationships, as shown in Figure 6.29b. Consider the alternative shown in Figure 6.29c. Discuss the relative merits of these two alternative representations of a ternary relationship by binary relationships.
- 6.26** Design a generalization – specialization hierarchy for a motor vehicle sales company. The company sells motorcycles, passenger cars, vans, and buses. Justify your placement of attributes at each level of the hierarchy. Explain why they should not be placed at a higher or lower level.
- 6.27** Explain the distinction between disjoint and overlapping constraints.
- 6.28** Explain the distinction between total and partial constraints.

Tools

Many database systems provide tools for database design that support E-R diagrams. These tools help a designer create E-R diagrams, and they can automatically create corresponding tables in a database. See bibliographical notes of Chapter 1 for references to database-system vendors' web sites.

There are also several database-independent data modeling tools that support E-R diagrams and UML class diagrams.

Dia, which is a free diagram editor that runs on multiple platforms such as Linux and Windows, supports E-R diagrams and UML class diagrams. To represent entities with attributes, you can use either classes from the UML library or tables from the Database library provided by Dia, since the default E-R notation in Dia represents attributes as ovals. The free online diagram editor *LucidChart* allows you to create E-R diagrams with entities represented in the same ways as we do. To create relationships, we suggest you use diamonds from the Flowchart shape collection. *Draw.io* is another online diagram editor that supports E-R diagrams.

Commercial tools include IBM Rational Rose Modeler, Microsoft Visio, ERwin Data Modeler, Poseidon for UML, and SmartDraw.

Further Reading

The E-R data model was introduced by [Chen (1976)]. The Integration Definition for Information Modeling (IDEF1X) standard [NIST (1993)] released by the United States National Institute of Standards and Technology (NIST) defined standards for E-R diagrams. However, a variety of E-R notations are in use today.

[Thalheim (2000)] provides a detailed textbook coverage of research in E-R modeling.

As of 2018, the current UML version was 2.5, which was released in June 2015. See www.uml.org for more information on UML standards and tools.