

- 12.3 The ER model uses a number of notations and tags to represent different concepts. Outline how the basic ER components are represented in an ER diagram.
- 12.4 Describe what the multiplicity constraint represents for a relationship type.
- 12.5 What are integrity constraints and how does multiplicity model these constraints?
- 12.6 How does multiplicity represent both the cardinality and the participation constraints on a relationship type?
- 12.7 Provide an example of a relationship type with attributes.
- 12.8 Distinguish between the Entity—Relationship model and the Entity—Relationship diagram.
- 12.9 Describe how fan and chasm traps can occur in an ER model and how they can be resolved.

Exercises

- 12.10 Create an ER model for each of the following descriptions:
 - (a) Each company operates four departments, and each department belongs to one company.
 - (b) Each department in part (a) employs one or more employees, and each employee works for one department.
 - (c) Each of the employees in part (b) may or may not have one or more dependents, and each dependent belongs to one employee.
 - (d) Each employee in part (c) may or may not have an employment history.
 - (e) Represent all the ER models described in (a), (b), (c), and (d) as a single ER model.
- 12.11 Assume you have been contracted by a university to develop a database system to keep track of student registration and accommodation records. The university courses are offered by faculties. Depending on the student's IQ, there are no limitations to how many courses a student can enroll in. The faculties are not responsible for student accommodation. The university owns a number of hostels and each student is given a shared room key after enrollment. Each room has furniture attached to it.
 - (a) Identify the main entity types for the project.
 - (b) Identify the main relationship types and specify the multiplicity for each relationship. State any assumptions that you make about the data.
 - (c) Using your answers for (a) and (b), draw a single ER diagram to represent the data requirements for the project.
- 12.12 Read the following case study, which describes the data requirements for a DVD rental company. The DVD rental company has several branches throughout the United States. The data held on each branch is the branch address made up of street, city, state, and zip code, and the telephone number. Each branch is given a branch number, which is unique throughout the company. Each branch is allocated staff, which includes a Manager. The Manager is responsible for the day-to-day running of a given branch. The data held on a member of staff is his or her name, position, and salary. Each member of staff is given a staff number, which is unique throughout the company. Each branch has a stock of DVDs. The data held on a DVD is the catalog number, DVD number, title, category, daily rental, cost, status, and the names of the main actors and the director. The catalog number uniquely identifies each DVD. However, in most cases, there are several copies of each DVD at a branch, and the individual copies are identified using the DVD number. A DVD is given a category such as Action, Adult, Children, Drama, Horror, or Sci-Fi. The status indicates whether a specific copy of a DVD is available for rent. Before borrowing a DVD from the company, a customer must first register as a member of a local branch. The data held on a member is the first and last name, address, and the date that the member registered at a branch. Each member is given a member number, which is unique throughout all branches of the company. Once registered, a member is free to rent DVDs, up to a maximum of ten at any one time. The data held on each DVD rented is the rental number, the full name and number of the member, the DVD number, title, and daily rental, and the dates the DVD is rented out and returned. The DVD number is unique throughout the company.
 - (a) Identify the main entity types of the DVD rental company.
 - (b) Identify the main relationship types between the entity types described in part (a) and represent each relationship as an ER diagram.

- (c) Determine the multiplicity constraints for each relationships described in part (b). Represent the multiplicity for each relationship in the ER diagrams created in part (b).
- (d) Identify attributes and associate them with entity or relationship types. Represent each attribute in the ER diagrams created in (c).
- (e) Determine candidate and primary key attributes for each (strong) entity type.
- (f) Using your answers to parts (a) to (e), attempt to represent the data requirements of the DVD rental company as a single ER diagram. State any assumptions necessary to support your design.

12.13 Create an ER model for each of the following descriptions:

- (a) A large organization has several parking lots, which are used by staff.
- (b) Each parking lot has a unique name, location, capacity, and number of floors (where appropriate).
- (c) Each parking lot has parking spaces, which are uniquely identified using a space number.
- (d) Members of staff can request the sole use of a single parking space. Each member of staff has a unique number, name, telephone extension number, and vehicle license number.
- (e) Represent all the ER models described in parts (a), (b), (c), and (d) as a single ER model. Provide any assumptions necessary to support your model.

The final answer to this exercise is shown as Figure 13.11.

12.14 Create an ER model to represent the data used by the library.

The library provides books to borrowers. Each book is described by title, edition, and year of publication, and is uniquely identified using the ISBN. Each borrower is described by his or her name and address and is uniquely identified using a borrower number. The library provides one or more copies of each book and each copy is uniquely identified using a copy number, status indicating if the book is available for loan, and the allowable loan period for a given copy. A borrower may loan one or many books, and the date each book is loaned out and is returned is recorded. Loan number uniquely identifies each book loan.

The answer to this exercise is shown as Figure 13.12.

- **Composition** is a specific form of aggregation that represents an association between entities, where there is a strong ownership and coincidental lifetime between the “whole” and the “part.”

Review Questions

- 13.1 What are the key differences between the ER and EER models?
- 13.2 Describe situations that would call for an enhanced entity–relationship in data modeling.
- 13.3 Describe and illustrate using an example the process of attribute inheritance.
- 13.4 What are the main reasons for introducing the concepts of superclasses and subclasses into an ER model?
- 13.5 Describe what a shared subclass represents and how this concept relates to multiple inheritance.
- 13.6 Describe and contrast the process of specialization with the process of generalization.
- 13.7 Describe the UML notation used to represent superclass/subclass relationships.
- 13.8 Describe and contrast the concepts of aggregation and composition and provide an example of each.

Exercises

- 13.9 Consider whether it is appropriate to introduce the enhanced concepts of specialization/generalization, aggregation, and/or composition for the case studies described in Appendix B.
- 13.10 The features of EER and ER models can co-exist in the same diagram. What situations lead to this co-existence? Analyze the case presented in question 12.11 and redraw the ER diagram as an EER diagram with the additional enhanced concepts.
- 13.11 Introduce specialization/generalization concepts into the ER model shown in Figure 13.11 and described in Exercise 12.13 to show the following:

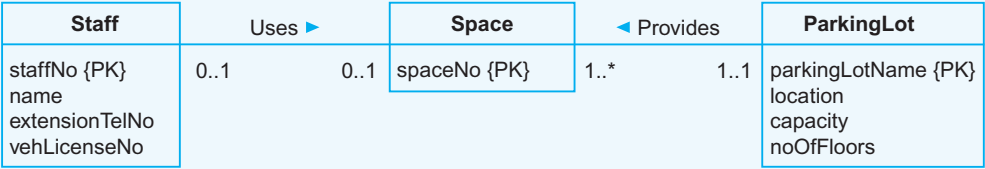


Figure 13.11 Parking lot ER model was described in Exercise 12.13.

- (a) The majority of parking spaces are under cover and each can be allocated for use by a member of staff for a monthly rate.
- (b) Parking spaces that are not under cover are free to use and each can be allocated for use by a member of staff.
- (c) Up to twenty covered parking spaces are available for use by visitors to the company. However, only members of staff are able to book out a space for the day of the visit. There is no charge for this type of booking, but the member of staff must provide the visitor's vehicle license number.

The final answer to this exercise is shown as Figure 17.11.

13.12 The library case study described in Exercise 12.14 is extended to include the fact that the library has a significant stock of books that are no longer suitable for loaning out. These books can be sold for a fraction of the original cost. However, not all library books are eventually sold as many are considered too damaged to sell on, or are simply lost or stolen. Each book copy that is suitable for selling has a price and the date that the book is no longer to be loaned out. Introduce enhanced concepts into the ER model shown in Figure 13.12 and described in Exercise 12.14 to accommodate this extension to the original case study.

The answer to this exercise is shown as Figure 17.12.

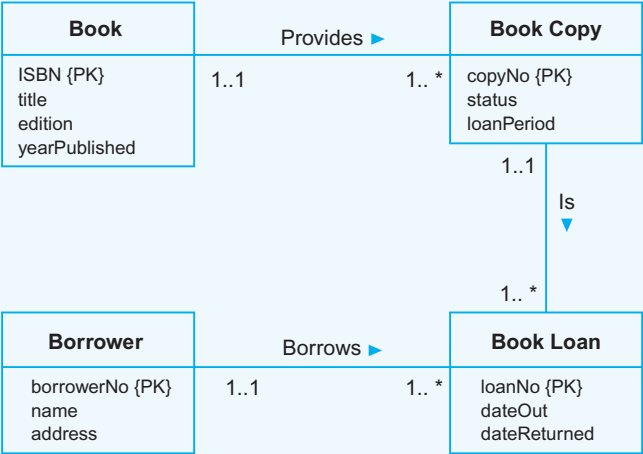


Figure 13.12 Library ER model was described in Exercise 12.14.