CSC343 Worksheet 14

July 9, 2020

1. **Exercise 4.1.1:** Design a database for a bank, including information about customers and their accounts. Information about a customer includes their name, address, phone, and Social Security number. Accounts have numbers, types (e.g., savings, checking) and balances. Also record the customer(s) who own an account. Draw the E/R diagram for this database. Be sure to include arrows where appropriate, to indicate the multiplicity of a relationship.

2. **Exercise 4.1.2:** Modify your solution to Exercise 4.1.1 as follows:

   a) Change your diagram so an account can have only one customer.

   b) Further change your diagram so a customer can have only one account.

   c) Change your original diagram of Exercise 4.1.1 so that a customer can have a set of addresses (which are street-city-state triples) and a set of phones. Remember that we do not allow attributes to have nonprimitive types, such as sets, in the E/R model.

   d) Further modify your diagram so that customers can have a set of addresses, and at each address there is a set of phones.

3. **Exercise 4.1.3:** Give an E/R diagram for a database recording information about teams, players, and their fans, including:

   1. For each team, its name, its players, its team captain (one of its players), and the colors of its uniform.
   2. For each player, his/her name.
   3. For each fan, his/her name, favorite teams, favorite players, and favorite color.

   Remember that a set of colors is not a suitable attribute type for teams. How can you get around this restriction?

4. **Exercise 4.1.4:** Suppose we wish to add to the schema of Exercise 4.1.3 a relationship Led-by among two players and a team. The intention is that this relationship set consists of triples (player1, player2, team) such that player 1 played on the team at a time when some other player 2 was the team captain.

a) Draw the modification to the E/R diagram.

b) Replace your ternary relationship with a new entity set and binary relationships.

c) Are your new binary relationships the same as any of the previously existing relationships? Note that we assume the two players are different, i.e., the team captain is not self-led.

5. **Exercise 4.1.5:** Modify Exercise 4.1.3 to record for each player the history of teams on which they have played, including the start date and ending date (if they were traded) for each such team.

6. **Exercise 4.1.6:** Design a genealogy database with one entity set: People. The information to record about persons includes their name (an attribute), their mother, father, and children.

7. **Exercise 4.1.7:** Modify your "people" database design of Exercise 4.1.6 to include the following special types of people:

   1. Females.
   2. Males.
   3. People who are parents

   You may wish to distinguish certain other kinds of people as well, so relationships connect appropriate subclasses of people.

8. **Exercise 4.1.8:** An alternative way to represent the information of Exercise 4.1.6 is to have a ternary relationship Family with the intent that in tht' relationship set for Family, triple (person, mother, father) is a person, their mother, and their father; all three are in the People entity set, of course.

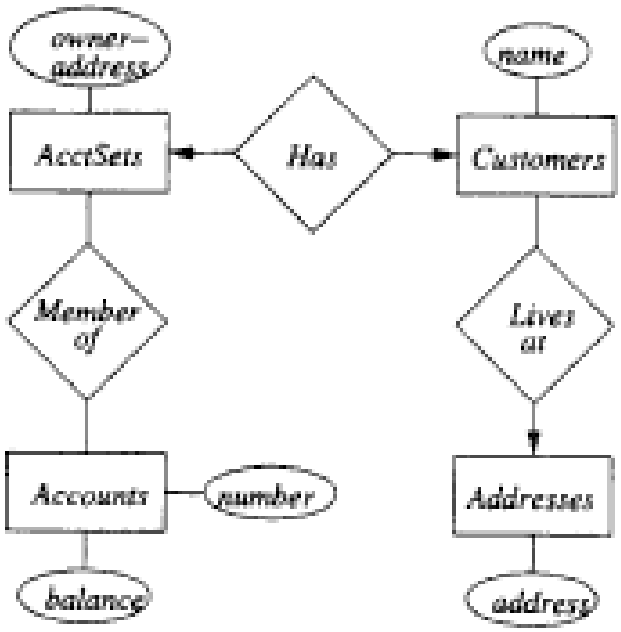
   a) Draw this diagram, placing arrows on edges where appropriate.

   b) Replace the ternary relationship Family by an entity set and binary relationships. Again place arrows to indicate the multiplicity of relationships.

9. **Exercise 4.1.9:** Design a database suitable for a university registrar. This database should include information about students, departments, professor , courses, which students are enrolled in which courses, which professors are teaching which courses, student grades, TA's for a course (TA's are students), which courses a department offers, and any other information you deem appropriate. Note that this question is more free-form than the questions above, and you need to make some decisions about multiplicities of relationships, appropriate types, and even what information needs to be represented.

10. **Exercise 4.1.10:** Informally, we can say that two E/R diagrams "have the same information" if, given a real-world situation, the instances of these two diagrams that reflect this situation can be computed from one another. Consider the E/R diagram of Fig. 4.6. This four-way relationship can be decomposed into a three-way relationship and a binary relationship by taking advantage of the fact that for each movie, there is a unique studio that produces that movie. Give an E/R diagram without a four-way relationship that has the same information as Fig. 4.6.

11. **Exercise 4.2.1:** In Fig. 4.14 is an E/R diagram for a bank database involving customers and accounts. Since customers may have several accounts, and accounts may be held jointly by several customers, we associate with each customer an "account set," and accounts are members of one or more account sets. Assuming the meaning of the various relationships and attributes are as expected given their names, criticize the design. What design rules are violated? Why? What modifications would you suggest?



12. **Exercise 4.2.2:** Under what circumstances (regarding the unseen attributes of Studios and Presidents) would you recommend combining the two entity sets and relationship in Fig. 4.3 into a single entity set and attributes?

13. **Exercise 4.2.3:** Suppose we delete the attribute address from Studios in Fig. 4.7. Show how we could then replace an entity set by an attribute. Where would that attribute appear?

14. **Exercise 4.2.4:** Give choices of attributes for the following entity sets in Fig. 4.13 that will allow the entity set to be replaced by an attribute:

Births, with four relationships, one between Births and each of the other entity sets, as suggested in Fig. 4.16. Use arrows (indicating that certain of these relationships are many-one) to represent the following conditions

a) Every baby is the result of a unique birth, and every birth is of a unique baby.

b) In addition to (a), every baby has a unique mother.

c) In addition to (a) and (b), for every birth there is a unique doctora) Every baby is the result of a unique birth, and every birth is of a unique baby.

In each case, what design flaws do you see?

15. **Exercise 4.4.1:** One way to represent students and the grades they get in courses is to use entity sets corresponding to students, to courses, and to "enrollments." Enrollment entities form a "connecting" entity set between students and courses and can be used to represent not only the fact that a student is taking a certain course, but the grade of the student in the course. Draw an E/R diagram for this situation, indicating weak entity sets and the keys for the entity sets. Is the grade part of the key for enrollments?

16. **Exercise 4.4.2:** Modify your solution to Exercise 4.4.1 so that we can record grades of the student for each of several assignments within a course. Again, indicate weak entity sets and keys.

17. **Exercise 4.4.3:** For your E/R diagrams of Exercise 4.2.6(a) (c), indicate weak entity sets, supporting relationships, and keys.

18. **Exercise 4.4.4:** Draw E/R diagrams for the following situations involving weak entity sets. In each case indicate keys for entity sets.

    a) Entity sets Courses and Departments. A course is given by a unique department, but its only attribute is its number. Different departments can offer courses with the same number. Each department has a unique name.

    b) Entity sets Leagues, Teams, and Players. League names are unique. No league has two teams with the same name. No team has two players with the same number. However, there can be players with the same number on different teams, and there can be teams with the same name in different leagues.

19. **Exercise 4.5.1:** Convert the E/R diagram of Fig. 4.29 to a relational database schema.

20. **Exercise 4.5.2:** There is another E/R diagram that could describe the weak entity set Bookings in Fig. 4.29. Notice that a booking can be identified uniquely by the flight number, day of the flight, the row, and the seat; the customer is not then necessary to help identify the booking.

Relations with Subset Schema

You might imagine from Example 4.30 that whenever one relation R has a set of attributes that is a subset of the attributes of another relation S, we can eliminate R. That is not exactly true. R might hold information that doesn't appear inS because the additional attributes of S do not allow us to extend a tuple from R to S.

For instance, the Internal Revenue Service tries to maintain a relation People (name, ss#) of potential taxpayers and their social-security numbers, even if the person had no income and did not file a tax return. They might also maintain a relation TaxPayers (name, ss#, amount) indicating the amount of tax paid by each person who filed a return in the current year. The schema of People is a subset of the schema of TaxPayers, yet there may be value in remembering the social-security number of those who are mentioned in People but not in Taxpayers.

In fact, even identical sets of attributes may have different semantics, so it is not possible to merge their tuples. An example would be two relations Stars (name, addr) and Studios (name, addr). Although the schemas look alike, we cannot turn star tuples into studio tuples, or viceversa. On the other hand, when the two relations come from the weak-entityset construction, then there can be no such additional value to the relation with the smaller set of attributes. The reason is that the tuples of the relation that comes from the supporting relationship correspond one-forone with the tuples of the relation that comes from the weak entity set. Thus, we routinely eliminate the former relation.

a) Revise the diagram of Fig. 4.29 to reflect this new viewpoint.

b) Convert your diagram from (a) into relations. Do you get the same database schema as in Exercise 4.5.1?

21. **Exercise 4.5.3:** The E/R diagram of Fig. 4.30 represents ships. Ships are said to be sisters if they were designed from the same plans. Convert this diagram to a relational database schema.

22. **Exercise 4.5.4:** Convert the following E/R diagrams to relational database schemas.

    a) Figure 4.22.

    b) Your answer to Exercise 4.4.1.

    c) Your answer to Exercise 4.4.4(a).

    d) Your answer to Exercise 4.4.4(b).

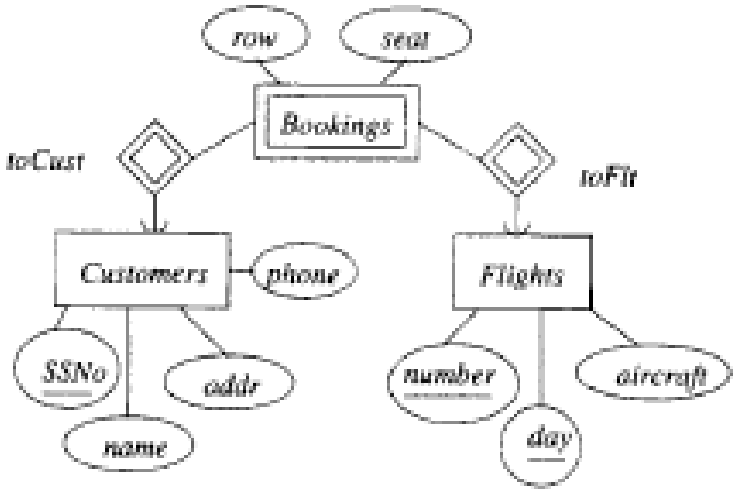


Figure 4.29: An E/R diagram about airlines

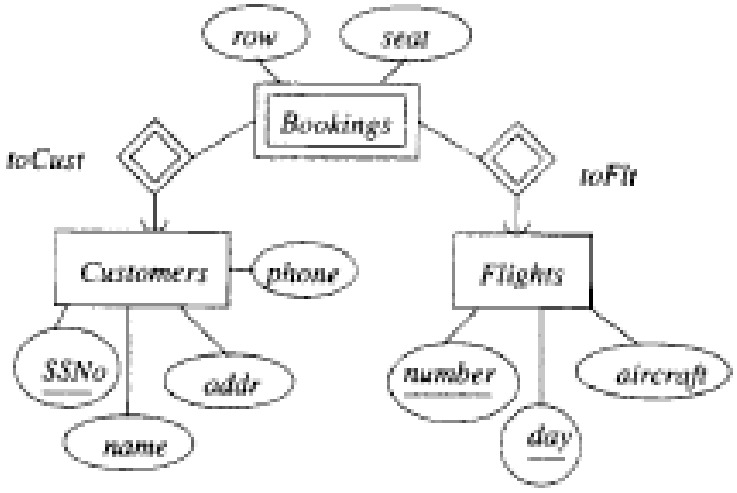


Figure 4.29: An E/R diagram about airlines

23. **Exercise 4.6.1:** Convert the E/R diagram of Fig. 4.32 to a relational database schema, using each of the following approaches:

    a) The straight-E/R method.

    b) The object-oriented method.

    c) The nulls method.

24. **Exercise 4.6.2:** Convert the E/R diagram of Fig. 4.33 to a relational database schema, using:

    a) The straight-E/R method.

b) The object-oriented method.

c) The nulls method.

25. **Exercise 4.6.3:** Convert your E/R design from Exercise 4.1.7 to a relational database schema, using

    a) The straight-E/R method.

    b) The object-oriented method.

    c) The nulls method.

26. **Exercise 4.6.4:** Suppose that we have an isa-hierarchy involving e entity sets. Each entity set has a attributes, and k of those at the root form the key for all these entity sets. Give formulas for (i) the minimum and maximum number of relations used, and (ii) the minimum and maximum number of components that the tuple(s) for a single entity have all together, when the method of conversion to relations is:

    a) The straight-E/R method.

    b) The object-oriented method.

    c) The nulls method.