Key Terms

association pattern
attribute
binary relationship
cardinality
child
composite identifier
crow's foot symbol
data model
degree
discriminator
entity
entity class
entity instance
entity-relationship (E-R) diagrams
entity-relationship (E-R) model
exclusive subtype
extended E-R model
HAS-A relationship
ID-dependent entity
identifier
identifying relationship
IE Crow's Foot model
inclusive subtype
Information Engineering (IE) model
Integrated Definition 1, Extended (IDEF1X)
IS-A relationship
mandatory
mandatory-to-mandatory (M-M) relationship
mandatory-to-optional (M-O) relationship
many-to-many (N:M) relationship
maximum cardinality
minimum cardinality
nonidentifying relationship
one-to-many (1:N) relationship
one-to-one (1:1) relationship
optional
optional-to-mandatory (O-M) relationship
optional-to-optional (O-O) relationship
owner entity
parent
recursive relationship
relationship
relationship class
relationship instance
requirements analysis
strong entity
subtype
supertype
systems analysis and design
systems development life cycle (SDLC)
ternary relationship
unary relationship
Unified Modeling Language (UML)
weak entity

Review Questions

5.1 Describe the two phases in designing databases that arise from the development of new information systems.

5.2 In general terms, explain how a data model could be used to design a database for a small video rental store.

5.3 Explain how a data model is like a building blueprint. What is the advantage of making changes during the data modeling stage?

5.4 Who is the author of the entity-relationship data model?

5.5 Define *entity*. Give an example of an entity (other than one presented in this chapter).

5.6 Explain the difference between an entity class and an entity instance.

5.7 Define *attribute*. Give an example attribute for the entity in your answer to Review Question 5.5.

5.8 Define *identifier*. Give an example identifier for the entity in your answer to Review Question 5.5.

5.9 Give an example of a composite identifier.

5.10 Define *relationship*. Give an example of a relationship (other than one presented in this chapter). Name your relationship.

5.11 Explain the difference between a relationship class and a relationship instance.

5.12 What is the degree of relationship? Give an example of a relationship of degree three (other than one presented in this chapter).

5.13 What is a binary relationship?

5.14 Explain the difference between an entity and a table. Why is this difference important?

5.15 What does cardinality mean?

5.16 Define the terms *maximum cardinality* and *minimum cardinality*.

5.17 Give examples of 1:1, 1:N, and N:M relationships (other than those presented in this chapter). Draw two E-R diagrams for each of your examples, one using the traditional diamond notation, and one using IE Crow's Foot notation.

5.18 Give an example for which the maximum cardinality must be an exact number.

5.19 Give examples of M-M, M-O, O-M, and O-O relationships (other than those presented in this chapter). Draw two E-R diagrams for each of your examples, one using the traditional diamond notation, and one using IE Crow's Foot notation.

5.20 Explain, in general terms, how the traditional E-R model, the IE Crow's Foot version, the IDEF1X version, and the UML version differ. Which version is used primarily in this text?

5.21 Explain how the notations shown in Figure 5-7 differ.

5.22 Explain how the notations shown in Figure 5-9 differ.

5.23 What is an ID-dependent entity? Give an example of an ID-dependent entity (other than one presented in this chapter).

5.24 Explain how to determine the minimum cardinality of both sides of an ID-dependent relationship.

5.25 What rules exist when creating an instance of an ID-dependent entity? What rules exist when deleting the parent of an ID-dependent entity?

5.26 What is an identifying relationship? How is it used?

5.27 Explain why the relationship between BUILDING and APARTMENT discussed on page 189 is an identifying relationship.

5.28 What is a weak entity? How do weak entities relate to ID-dependent entities?

5.29 What distinguishes a weak entity from a strong entity that has a required relationship to another entity?

5.30 Define *subtype* and *supertype*. Give an example of a subtype–supertype relationship (other than one presented in this chapter).

5.31 Explain the difference between exclusive subtypes and inclusive subtypes. Give an example of each.

5.32 What is a discriminator?

5.33 Explain the difference between IS-A and HAS-A relationships.

5.34 What is the most important reason for using subtypes in a data model?

5.35 Describe the relationship between the structure of forms and reports and the data model.

5.36 Explain two ways forms and reports are used for data modeling.

5.37 Explain why the form and report in Figure 5-15 indicate that the underlying relationship is 1:1.

5.38 Why is it not possible to infer minimum cardinality from the form and report in Figure 5-15?

5.39 Describe two tests for determining if an entity is a strong entity.

5.40 Why does the form in Figure 5-17 not indicate that the underlying relationship is 1:N? What additional information is required to make that assertion?

5.41 Explain why two forms or reports are usually needed to infer maximum cardinality.

5.42 How can you assess minimum cardinality for the entities in the form in Figure 5-17?

5.43 Explain why the form and report in Figure 5-19 indicate that the underlying relationship is N:M.

5.44 Name three patterns that use ID-dependent relationships.

5.45 Explain how the association pattern differs from the N:M strong entity pattern. What characteristic of the report in Figure 5-21 indicates that an association pattern is needed?

5.46 In general terms, explain how to differentiate an N:M strong entity pattern from an association pattern.

5.47 Explain why two entities are needed to model multivalued attributes.

5.48 How do the forms in Figures 5-26 and 5-28 differ? How does this difference affect the data model?

5.49 Describe, in general terms, the archetype/instance pattern. Why is an ID-dependent relationship needed for this pattern? Use the CLASS/SECTION example shown in Figure 5-30 in your answer.

5.50 Explain what caused the entities in Figure 5-31 to change from ID-dependent entities.

5.51 Summarize the two sides in the argument about the importance of weak, but not ID-dependent, entities.

5.52 Give an example of the line-item pattern as it could be used to describe the contents of a shipment. Assume that the shipment includes the names and quantities of various items as well as each item's insured value. Place the insurance value per item in an ITEM entity.

5.53 What entity type should come to mind when you see the words "For use by" in a form?

5.54 Give examples of 1:1, 1:N, and N:M recursive relationships (other than those presented in this chapter).

5.55 Explain why the data modeling process must be iterative. Use the Highline University example.

Project Questions

Answer the following questions using IE Crow's Foot notation.

5.56 Examine the subscription form shown in Figure 5-53. Using the structure of this form, do the following:

A. Create a model with one entity. Specify the identifier and attributes.

B. Create a model with two entities, one for customer and a second for subscription. Specify identifiers, attributes, relationship name, type, and cardinalities.

Fine Wood Working

To subscribe

☐ 1 year (6 issues) for just $18—20% off the newsstand price.
(Outside the U.S. $21/year—U.S. funds, please)

☐ 2 years (12 issues) for just $34—save 24%
(Outside the U.S. $40/2 years—U.S. funds, please)

Name _____

Address _____

City _____ State _____ Zip _____

☐ My payment is enclosed. ☐ Please bill me.

Please start my subscription with ☐ *current issue* ☐ *next issue*.

Figure 5-53
Subscription Form

C. Under what conditions do you prefer the model in A to that in B?

D. Under what conditions do you prefer the model in B to that in A?

5.57 Examine the list of e-mail messages in Figure 5-54. Using the structure and example data items in this list, do the following:

A. Create a single-entity data model for this list. Specify the identifier and all entities.

B. Modify your answer to A to include entities SENDER and SUBJECT. Specify the identifiers and attributes of entities and the type and cardinalities of the relationships. Explain which cardinalities can be inferred from Figure 5-54 and which need to be checked out with users.

C. The e-mail address in the From column in Figure 5-54 is in two different styles. One style has the true e-mail address; the second style (e.g., Tom Cooper) is the name of an entry in the user's e-mail directory. Create two categories of SENDER based on these two styles. Specify identifiers and attributes.

Figure 5-54
Email List

From	Subject	Date ↓	Size
WDA2259@sailmail.com	Big Wind	5/13/2013	3 KB
WDA2259@sailmail.com	Update	5/12/2013	4 KB
WDA2259@sailmail.com	Re: Saturday Am	5/11/2013	4 KB
WDA2259@sailmail.com	Re: Weather window!	5/10/2013	4 KB
WDA2259@sailmail.com	Re: Howdy!	5/10/2013	3 KB
WDA2259@sailmail.com	Still here	5/9/2013	3 KB
WDA2259@sailmail.com	Re: Turle Bay	5/8/2013	4 KB
WDA2259@sailmail.com	Turle Bay	5/8/2013	4 KB
WDA2259@sailmail.com	Re: Hi	5/6/2013	3 KB
WDA2259@sailmail.com	Sunday, Santa Maria	5/5/2013	3 KB
Ki6yu@aol.com	Cabo, Thurs. Noon	5/2/2013	2 KB
WDA2259@sailmail.com	turbo	5/1/2013	3 KB
WDA2259@sailmail.com	on our way	4/28/2013	3 KB
Tom Cooper	RE: Hola!	4/26/2013	3 KB
Tom Cooper	RE: Hola!	4/24/2013	2 KB
Tom Cooper	RE: Hola!	4/23/2013	3 KB

5.58 Examine the list of stock quotes in Figure 5-55. Using the structure and example data items in this list, do the following:

A. Create a single-entity data model for this list. Specify the identifier and attributes.

B. Modify your answer to A to include the entities COMPANY and INDEX. Specify the identifier and attributes of the entities and the type and cardinalities of the relationships. Explain which cardinalities can be inferred from Figure 5-55 and which need to be checked out with users.

C. The list in Figure 5-55 is for a quote on a particular day at a particular time of day. Suppose that the list were changed to show closing daily prices for each of these stocks and that it includes a new column: QuoteDate. Modify your model in B to reflect this change.

D. Change your model in C to include the tracking of a portfolio. Assume the portfolio has an owner name, a phone number, an e-mail address, and a list of stocks held. The list includes the identity of the stock and the number of shares held. Specify all additional entities, their identifiers and attributes, and the type and cardinality of all relationships.

E. Change your answer to part D to keep track of portfolio stock purchases and sales in a portfolio. Specify entities, their identifiers and attributes, and the type and cardinality of all relationships.

5.59 Figure 5-56 shows the specifications for single-stage air compressor products. Note that there are two product categories that are based on Air Performance: The A models are at 125 pounds per square inch of pressure, and the E models are at 150 pounds per square inch of pressure. Using the structure and example data items in this list, do the following:

A. Create a set of exclusive subtypes to represent these compressors. The supertype will have attributes for all single-stage compressors, and the subtypes will have attributes for products having the two different types of Air Performance. Assume that there might be additional products with different types of Air Performance. Specify the entities, identifiers, attributes, relationships, type of category cluster, and possible determinant.

Figure 5-55
Stock Quotations

Symbol	Name	Last	Change	% Chg
$COMPX	Nasdaq Combined Composite Index	1,400.74 ▼	-4.87	-0.35%
$INDU	Dow Jones Industrial Average Index	9,255.10 ▼	-19.80	-0.21%
$INX	S&P 500 INDEX	971.14 ▼	-5.84	-0.60%
ALTR	Altera Corporation	13.45 ▼	-0.450	-3.24%
AMZN	Amazon.com, Inc.	15.62 ▲	+0.680	+4.55%
CSCO	Cisco Systems, Inc.	13.39 ▼	-0.280	-2.05%
DELL	Dell Computer Corporation	24.58 ▼	-0.170	-0.69%
ENGCX	Enterprise Growth C	14.60 ▼	-0.210	-1.42%
INTC	Intel Corporation	18.12 ▼	-0.380	-2.05%
JNJ	Johnson & Johnson	53.29 ▼	-0.290	-0.54%
KO	Coca-Cola Company	56.70 ▼	-0.580	-1.01%
MSFT	Microsoft Corporation	53.96 ▲	+1.040	+1.97%
NKE	NIKE, Inc.	57.34 ▲	+0.580	+1.02%

Single Stage

Set 95 to 150 PSI also available, substitute "E" for "A" in model number. i.e., K15A-30 make K15E-30

HP	Model	Tank Gal	Air Performance						Approx Ship Weight	Dimensions		
			A @ 125			E@ 150				L	W	H
			Pump RPM	CFM Disp	DEL'D Air	Pump RPM	CFM Disp	DEL'D Air				
1/2	F12A-17	17	680	3.4	2.2	590	2.9	1.6	135	37	14	25
3/4	F34A-17	17	1080	5.3	3.1	950	4.7	2.3	140	37	14	25
3/4	F34A-30	30	1080	5.3	3.1	950	4.7	2.3	160	38	16	31
1	K1A-30	30	560	6.2	4.0	500	5.7	3.1	190	38	16	34
1 1/2	K15A-30	30	870	9.8	6.2	860	9.7	5.8	205	49	20	34
1 1/2	K15A-60	60	870	9.8	6.2	860	9.7	5.8	315	38	16	34
2	K2A-30	30	1140	13.1	8.0	1060	12.0	7.0	205	49	20	39
2	K2A-60	60	1140	13.1	8.0	1060	12.0	7.0	315	48	20	34
2	GC2A-30	30	480	13.1	9.1	460	12.4	7.9	270	38	16	36
2	GC2A-60	60	480	13.1	9.1	460	12.4	7.9	370	49	20	41
3	GC3A-60	60	770	21.0	14.0	740	19.9	12.3	288	38	16	36
5	GC5A-80	60	770	21.0	14.0	740	19.9	12.3	388	49	20	41
5	GC5A-60	60	1020	27.8	17.8	910	24.6	15.0	410	49	20	41
5	GC5A-80	80	1020	27.8	17.8	910	24.6	15.0	450	62	20	41
5	J5A-80	60	780	28.7	19.0	770	28.6	18.0	570	49	23	43
5	J5A-80	80	780	28.7	19.0	770	28.6	18.0	610	63	23	43

Figure 5-56
Air Compressor Specifications

B. Figure 5-56 shows a different model for the compressor data. Explain the entities, their type, the relationship, its type, and its cardinality. How well do you think this model fits the data shown in Figure 5-56?

C. Compare your answer in part A with the model in Figure 5-57. What are the essential differences between the two models? Which do you think is better?

D. Suppose you had the job of explaining the differences in these two models to a highly motivated, intelligent end user. How would you accomplish this?

5.60 Figure 5-58 shows a listing of movie times at theaters in Seattle, Washington. Using the data in this figure as an example, do the following:

A. Create a model to represent this report using the entities MOVIE, THEATER, and SHOW_TIME. Assume that theaters may show multiple movies. Although this report is for a particular day, your data model should allow for movie times on different days as well. Specify the identifier of the entities and their attributes. Name the relationships and the type and cardinality of all relationships. Explain which cardinalities you can logically deduce from Figure 5-58 and which need to be checked out with users. Assume that distance is an attribute of THEATER.

B. This report was prepared for a user who is located near downtown Seattle. Suppose that it is necessary to produce this same report for these theaters, but for a user located in a Seattle suburb, such as Bellevue, Renton, Redmond, or Tacoma.

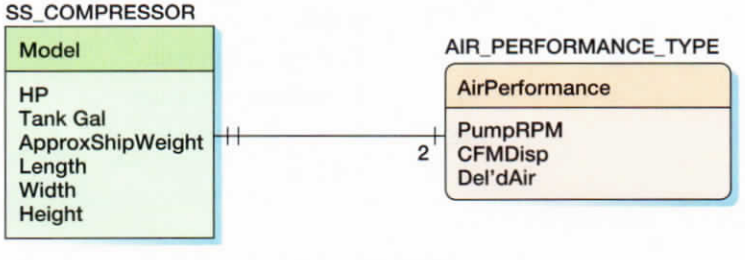


Figure 5-57
Alternative Model for Compressor Data

Movie

Lincoln

Daniel Day-Lewis, Sally Field, David Strathairn, and Tommy Lee Jones lead a stand-out cast in this historical drama.

Local Theaters and Showtimes

40 miles from the center of Seattle, WA Change Area
Tue, Jul 9 Wed Thu Fri Sat

Displaying 1 - 32 results, sorted by distance.

AMC Pacific Place 11 (0.5 miles)
600 Pine St, Seattle (206) 652-2404
Showtimes: 11:00 am, 12:00 pm, 12:45 pm, 1:30 pm, 2:30 pm, 3:15 pm, 4:00 pm, 5:00 pm, 5:45 pm, 6:30 pm, 7:30 pm, 8:30 pm, 9:00 pm, 10:00 pm, 10:45 pm

Neptune Theatre (3.9 miles)
1303 NE 45th, Seattle (206) 633-5545
Showtimes: 11:20 am, 1:30 pm, 3:40 pm, 5:50 pm, 8:00 pm, 10:10 pm

Regal Bellevue Galleria 11 (6.2 miles)
500 106th Ave NE, Bellevue (425) 451-7161
Showtimes: 11:00 am, 11:30 am, 1:00 pm, 1:30 pm, 3:00 pm, 3:30 pm, 5:05 pm, 5:35 pm, 7:10 pm, 7:40 pm, 9:20 pm, 9:50 pm

LCE Oak Tree Cinema (6.6 miles)
10006 Aurora Ave N., Seattle (206) 527-1748
Showtimes: 11:45 am, 2:15 pm, 4:45 pm, 7:15 pm, 9:45 pm

LCE Factoria Cinemas 8 (7.8 miles)
3505 Factoria Blvd SE, Bellevue (425) 641-9206
Showtimes: 12:00 pm, 1:00 pm, 2:15 pm, 3:15 pm, 4:30 pm, 5:45 pm, 7:30 pm, 8:15 pm, 9:45 pm, 10:30 pm

Kirkland Parkplace Cinema (8 miles)
404 Parkplace Ctr, Kirkland (425) 827-9000
Showtimes: 12:15 pm, 2:30 pm, 4:45 pm, 7:20 pm, 9:35 pm

Figure 5-58
Movie Time Listing

In this case, distance cannot be an attribute of THEATER. Change your answer in A for this situation. Specify the entity identifiers and attributes. Name the relationships and identify the type and cardinality of all relationships.

C. Suppose that you want to make this data model national. Change your answer to B so that it can be used for other metropolitan areas. Change your answer in A for this situation. Specify the entity identifiers and attributes. Name the relationships and identify the type and cardinality of all relationships.

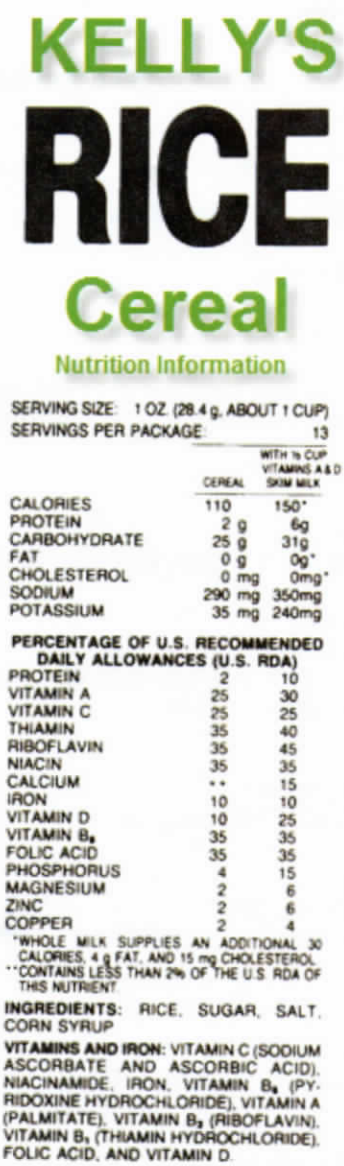
D. Modify your answer to C to include the leading cast members. Assume that the role of a cast member is not to be modeled. Specify the identifier of new entities and their attributes. Name the relationships and identify the type and cardinality of all relationships.

E. Modify your answer to C to include the leading cast members. Assume that the role of a cast member is specified. Specify the identifier of new entities and their attributes. Name the relationships and identify the type and cardinality of all relationships.

5.61 Consider the three reports in Figure 5-59. The data are samples of data that would appear in the reports like these.

A. Make a list of as many potential entities as these reports suggest.

B. Examine your list to determine whether any entities are synonyms. If so, consolidate your list.



KELLY'S
RICE
Cereal
Nutrition Information

SERVING SIZE: 1 OZ. (28.4 g, ABOUT 1 CUP)
SERVINGS PER PACKAGE: 13

	CEREAL	WITH ½ CUP VITAMINS A & D SKIM MILK
CALORIES	110	150*
PROTEIN	2 g	6g
CARBOHYDRATE	25 g	31g
FAT	0 g	0g*
CHOLESTEROL	0 mg	0mg*
SODIUM	290 mg	350mg
POTASSIUM	35 mg	240mg

PERCENTAGE OF U.S. RECOMMENDED DAILY ALLOWANCES (U.S. RDA)

PROTEIN	2	10
VITAMIN A	25	30
VITAMIN C	25	25
THIAMIN	35	40
RIBOFLAVIN	35	45
NIACIN	35	35
CALCIUM	**	15
IRON	10	10
VITAMIN D	10	25
VITAMIN B_6	35	35
FOLIC ACID	35	35
PHOSPHORUS	4	15
MAGNESIUM	2	6
ZINC	2	6
COPPER	2	4

*WHOLE MILK SUPPLIES AN ADDITIONAL 30 CALORIES, 4 g FAT, AND 15 mg CHOLESTEROL.
**CONTAINS LESS THAN 2% OF THE U.S. RDA OF THIS NUTRIENT.

INGREDIENTS: RICE, SUGAR, SALT, CORN SYRUP

VITAMINS AND IRON: VITAMIN C (SODIUM ASCORBATE AND ASCORBIC ACID), NIACINAMIDE, IRON, VITAMIN B_6 (PYRIDOXINE HYDROCHLORIDE), VITAMIN A (PALMITATE), VITAMIN B_2 (RIBOFLAVIN), VITAMIN B_1 (THIAMIN HYDROCHLORIDE), FOLIC ACID, AND VITAMIN D.

FDA REPORT #6272
Date: June 30, 2011
Issuer: Kelly's Corporation
Report Title: Product Summary by Ingredient

Corn	Kelly's Corn Cereal
	Kelly's Multigrain Cereal
	Kelly's Crunchy Cereal
Corn syrup	Kelly's Corn Cereal
	Kelly's Rice Cereal
	Kelly's Crunchy Cereal
Malt	Kelly's Corn Cereal
	Kelly's Crunchy Cereal
Wheat	Kelly's Multigrain Cereal
	Kelly's Crunchy Cereal

(a)

SUPPLIERS LIST
Date: June 30, 2011

Ingredient	Supplier	Price
Corn	Wilson	2.80
	J. Perkins	2.72
	Pollack	2.83
	McKay	2.80
Wheat	Adams	1.19
	Kroner	1.19
	Schmidt	1.22
Barley	Wilson	0.85
	Pollack	0.84

(b)

Figure 5-59
Cereal Product Reports

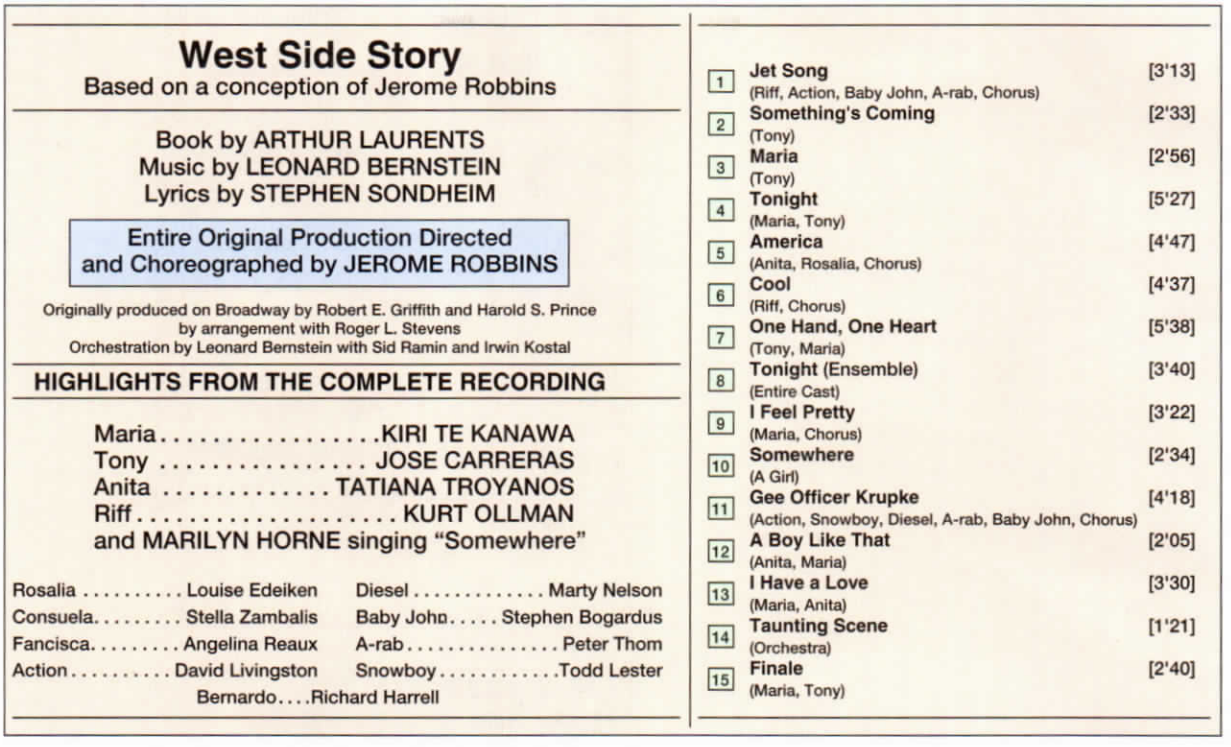
C. Construct an IE Crow's Foot model showing relationships among your entities. Name each relationship and specify cardinalities. Indicate which cardinalities you can justify on the basis of these reports and which you will need to check out with the users.

5.62 Consider the CD cover in Figure 5-60.

A. Specify identifiers and attributes for the entities CD, ARTIST, ROLE, and SONG.

B. Construct a crow's foot model showing relationships among these four entities. Name each relationship and specify cardinalities. Indicate which cardinalities you can justify on the basis of the CD cover and which you will need to check out with the users.

C. Consider a CD that does not involve a musical, so there is no need for ROLE. However, the entity SONG_WRITER is needed. Create a crow's foot model for CD, ARTIST, SONG, and SONG_WRITER. Assume that an ARTIST can either be a group or an individual. Assume that some artists record individually and as part of a group.



West Side Story
Based on a conception of Jerome Robbins

Book by ARTHUR LAURENTS
Music by LEONARD BERNSTEIN
Lyrics by STEPHEN SONDHEIM

Entire Original Production Directed and Choreographed by JEROME ROBBINS

Originally produced on Broadway by Robert E. Griffith and Harold S. Prince
by arrangement with Roger L. Stevens
Orchestration by Leonard Bernstein with Sid Ramin and Irwin Kostal

HIGHLIGHTS FROM THE COMPLETE RECORDING

Maria . . . . . KIRI TE KANAWA
Tony . . . . . JOSE CARRERAS
Anita . . . . . TATIANA TROYANOS
Riff . . . . . KURT OLLMAN
and MARILYN HORNE singing "Somewhere"

Rosalia . . . . . Louise Edeiken
Consuela. . . . . Stella Zambalis
Fancisca. . . . . Angelina Reaux
Action . . . . . David Livingston
Bernardo . . . . Richard Harrell
Diesel . . . . . Marty Nelson
Baby John. . . . . Stephen Bogardus
A-rab . . . . . Peter Thom
Snowboy . . . . . Todd Lester

1	**Jet Song** (Riff, Action, Baby John, A-rab, Chorus)	[3'13]
2	**Something's Coming** (Tony)	[2'33]
3	**Maria** (Tony)	[2'56]
4	**Tonight** (Maria, Tony)	[5'27]
5	**America** (Anita, Rosalia, Chorus)	[4'47]
6	**Cool** (Riff, Chorus)	[4'37]
7	**One Hand, One Heart** (Tony, Maria)	[5'38]
8	**Tonight** (Ensemble) (Entire Cast)	[3'40]
9	**I Feel Pretty** (Maria, Chorus)	[3'22]
10	**Somewhere** (A Girl)	[2'34]
11	**Gee Officer Krupke** (Action, Snowboy, Diesel, A-rab, Baby John, Chorus)	[4'18]
12	**A Boy Like That** (Anita, Maria)	[2'05]
13	**I Have a Love** (Maria, Anita)	[3'30]
14	**Taunting Scene** (Orchestra)	[1'21]
15	**Finale** (Maria, Tony)	[2'40]

Figure 5-60
CD Cover

D. Combine the models you developed in your answers to B and C. Create new entities if necessary, but strive to keep your model as simple as possible. Specify identifiers and attributes of new entities, name new relationships, and indicate their cardinalities.

5.63 Consider the data model in Figure 5-43. How should this model be altered if the users want to keep track of how many of each part are used? Suppose, for example, that the wheel assembly requires four washers and the handle assembly requires just one, and the database must store these quantities. (Hint: Adding Quantity to this N:M relationship is analogous to adding Price to the N:M relationship in Figure 5-22.)

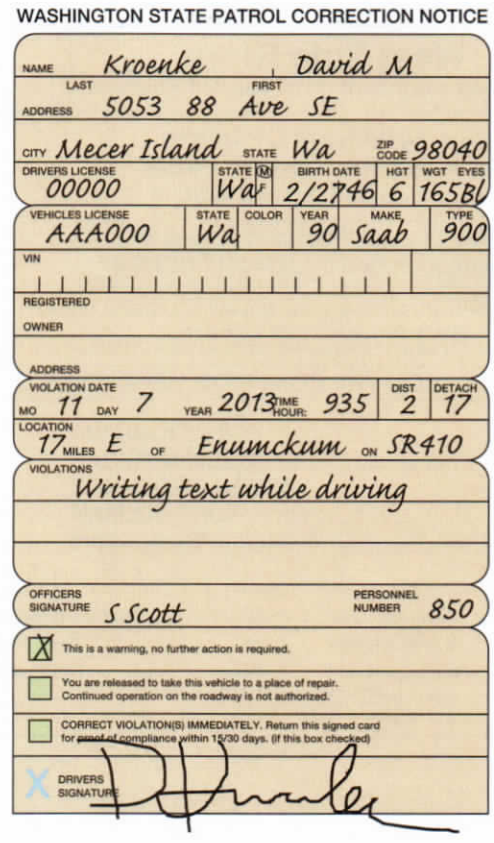
5.64 The data model in Figure 5-52 uses the attribute Room in COLLEGE and DEPARTMENT, but uses OfficeNumber in PROFESSOR. These attributes have the same kind of data, even though they have different names. Examine Figure 5-46 and explain how this situation came to be. Do you think having different names for the same attribute types is rare? Do you think it is a problem? Why or why not?

Case Questions

Washington State Patrol Case Questions

Consider the Washington State Patrol traffic citation shown in Figure 5-61. The rounded corners on this form provide graphical hints about the boundaries of the entities represented.

A. Draw an E-R data model based on the traffic citation form. Use five entitiesn, and use the data items on the form to specify identifiers and attributes for those entities. Use the IE Crow's Foot E-R model for your diagram


WASHINGTON STATE PATROL CORRECTION NOTICE

NAME LAST Kroenke FIRST David M

ADDRESS 5053 88 Ave SE

CITY Mecer Island STATE Wa ZIP CODE 98040

DRIVERS LICENSE 00000 STATE Wa M F BIRTH DATE 2/2746 HGT 6 WGT 165 EYES Bl

VEHICLES LICENSE AAA000 STATE Wa COLOR YEAR 90 MAKE Saab TYPE 900

VIN

REGISTERED OWNER

ADDRESS

VIOLATION DATE MO 11 DAY 7 YEAR 2013 TIME HOUR: 935 DIST 2 DETACH 17

LOCATION 17 MILES E OF Enumckum ON SR410

VIOLATIONS Writing text while driving

OFFICERS SIGNATURE S Scott PERSONNEL NUMBER 850

☒ This is a warning, no further action is required.

☐ You are released to take this vehicle to a place of repair. Continued operation on the roadway is not authorized.

☐ CORRECT VIOLATION(S) IMMEDIATELY. Return this signed card for proof of compliance within 15/30 days. (if this box checked)

X DRIVERS SIGNATURE

Figure 5-61
Traffic Citation

B. Specify relationships among the entities. Name the relationships, and specifiy the relationship types and cardinalities. Justify the decisions you make regarding minimum and maximum cardinalities, indicating which cardinalities can be inferred from data on the form and which need to be checked out with systems users.

Highline University Mentor Program Case Questions

Highline University is a four-year undergraduate school located in the Puget Sound region of Washington State. A discussion of the design of a college information system for Highline University appears in this chapter on pages 209–215 as an example of creating data models, and a variant of that discussion is used in Appendix B, "Getting Started with Systems and Analysis and Design."

In this set of case questions, we will consider a different information system for Highline University, one that will be used by Highline University's Mentor Program. The Highline University Mentor Program recruits business professionals as mentors for Highline University students. The mentors are unpaid volunteers who work together with the students' advisers to ensure that the students in the mentoring program learn needed and relevant management skills. In this case study, you will develop a data model for the Mentor Program Information System.

Highline University, like many colleges and universities in the Pacific Northwest (see *http://en.wikipedia.org/wiki/Pacific_Northwest*) is accredited by the Northwest Commission on Colleges and Universities (NWCCU—see *www.nwccu.org*). Like all the colleges and universities accredited by the NWCCU, Highline University must be reaccredited at approximately five-year intervals. Additionally, the NWCCU requires annual status-update reports.

Highline University is made up of five colleges: The College of Business, the College of Social Sciences and Humanities, the College of Performing Arts, the College of Sciences and Technology, and the College of Environmental Sciences. Jan Smathers is the president of Highland University, and Dennis Endersby is the Provost (a Provost is a vice president of academics, and the deans of the colleges report to the Provost). Highline University is a fictional university and should not be confused with Highline Community College located in Des Moines, Washington. Any resemblance between Highline University and Highline Community College is unintentional and purely coincidental.

A. Draw an E-R data model for the Highline University Mentor Program Information System (MPIS). Use the IE Crow's Foot E-R model for your E-R diagrams. Justify the decisions you make regarding minimum and maximum cardinality.

Your model should track students, advisers, and mentors. Additionally, Highline University needs to track alumni because the program administrators view alumni as potential mentors.

1. Create separate entities for students, alumni, faculty advisers, and mentors.
   - At Highline University, all students are required to live on campus and are assigned Highline University ID numbers and e-mail accounts in the format *FirstName.LastName@students.hu.edu*. The student entity should track student last name, student first name, student University ID number, student e-mail address, dorm name, dorm room number, and dorm phone number.
   - At Highline University, all faculty advisers have on-campus offices and are assigned Highline University ID numbers and e-mail accounts in the format *FirstName.LastName@hu.edu*. The faculty entity should track faculty last name, faculty first name, faculty University ID number, faculty e-mail address, department, office building name, office building room number, and office phone number.
   - Highline University alumni live off campus and were previously assigned Highline University ID numbers. Alumni have private e-mail accounts in the format *FirstName.LastName@somewhere.com*. The alumni entity should track alumnus last name, alumnus first name, alumnus former student number, e-mail address, home address, home city, home state, home ZIP code, and phone number.
   - Highline University mentors work for companies and use their company address, phone, and e-mail address for contact information. They do not have Highline University ID numbers as mentors. E-mail addresses are in the format *FirstName.LastName@companyname.com*. The mentor entity should track mentor last name, mentor first name, mentor e-mail address, company name, company address, company city, company state, company ZIP code, and company phone number.
2. Create relationships between entities based on the following facts:
   - Each student is assigned one and only one faculty adviser and must have an adviser. One faculty member may advise several students, but faculty members are not required to advise students. Only the fact of this assignment is to be recorded in the data model—not possible related data (such as the date the adviser was assigned to the student).
   - Each student may be assigned one and only one mentor, but students are not required to have a mentor. One mentor may mentor several students, and a person may be listed as a mentor before he or she is actually assigned students to mentor. Only the fact of this assignment is to be recorded in the data model—not possible related data (such as the date the mentor was assigned to the student).
   - Each mentor is assigned to work and coordinate with one and only one faculty member, and each mentor must work with a faculty member. One faculty member may work with several mentors, but faculty members are not required to work with mentors. Only the fact of this assignment is to be recorded in the data model—not possible related data (such as the date the faculty member was assigned to the mentor).
   - Each mentor may be an alumnus, but mentors are not required to be alumni. Alumni cannot, of course, be required to become mentors.

B. Revise the E-R data model you created in part A to create a new E-R data model based on the fact that students, faculty, alumni, and mentors are all a PERSON. Use the IE Crow's Foot E-R model for your E-R diagrams. Justify the decisions you make regarding minimum and maximum cardinality. Note that:

- A person may be a current student, an alumnus, or both because Highline University does have alumni return for further study.
- A person may be a faculty member or a mentor, but not both.

- A person may be a faculty member and an alumnus.
- A person may be a mentor and an alumnus.
- A current student cannot be a mentor.
- Each mentor may be an alumnus, but mentors are not required to be alumni.
- Alumni cannot, of course, be required to become mentors.

C. Extend and modify the E-R data model you created in part B to allow more data to be recorded in the MPIS system. Use the IE Crow's Foot E-R model for your E-R diagrams. Justify the decisions you make regarding minimum and maximum cardinality. The MPIS needs to record:

- The date a student enrolled at Highline University, the date the student graduated, and the degree the student received.
- The date an adviser was assigned to a student and the date the assignment ended.
- The date an adviser was assigned to work with a mentor and the date the assignment ended.
- The date a mentor was assigned to a student and the date the assignment ended.

D. Write a short discussion of the difference between the three data models you have created. How does data model B differ from data model A, and how does data model C differ from data model B? What additional features of the E-R data model were introduced when you created data models B and C?

The Queen Anne Curiosity Shop

The Queen Anne Curiosity Shop wants to expand its database applications beyond the current recording of sales. The company still wants to maintain data on customers, employees, vendors, sales, and items, but it wants to (a) modify the way it handles inventory and (b) simplify the storage of customer and employee data.

Currently, each item is considered unique, which means the item must be sold as a whole, and multiple units of the item in stock must be treated as separate items in the ITEM table. The Queen Anne Curiosity Shop management wants the database modified to include an inventory system that will allow multiple units of an item to be stored under one ItemID. The system should allow for a quantity on hand, a quantity on order, and an order due date. If the identical item is stocked by multiple vendors, the item should be orderable from any of these vendors. The SALE_ITEM table should then include Quantity and ExtendedPrice columns to allow for sales of multiple units of an item.

The Queen Anne Curiosity Shop management has noticed that some of the fields in CUSTOMER and EMPLOYEE store similar data. Under the current system, when an employee buys something at the store, his or her data has to be reentered into the CUSTOMER table. The managers would like to have the CUSTOMER and EMPLOYEE tables redesigned using subtypes.

A. Draw an E-R data model for The Queen Anne Curiosity Shop database schema shown in Chapter 3. Use the IE Crow's Foot E-R model for your E-R diagrams. Justify the decisions you make regarding minimum and maximum cardinality.

B. Extend and modify the E-R data model by adding only The Queen Anne Curiosity Shop's inventory system requirements. Use the IE Crow's Foot E-R model for your E-R diagrams. Create appropriate identifiers and attributes for each entity. Justify the decisions you make regarding minimum and maximum cardinality.

C. Extend and modify the E-R data model by adding only The Queen Anne Curiosity Shop's need for more efficient storage of CUSTOMER and EMPLOYEE data. Use the IE Crow's Foot E-R model for your E-R diagrams. Create appropriate identifiers and attributes for each entity. Justify the decisions you make regarding minimum and maximum cardinality.

D. Combine the E-R data models from parts B and C to meet all of The Queen Anne Curiosity Shop's new requirements, making additional modifications, as needed. Use the IE Crow's Foot E-R model for your E-R diagrams.

E. Describe how you would go about validating your data model in part D.

Morgan Importing

James Morgan of Morgan Importing has decided to expand his business and needs to staff and support a *procurement system*[6] to acquire the items sold at Morgan Importing. Suppose that you have been hired to create and implement a database application to support a procurement information system. Data in this procurement information system will include:

- **The purchasing agents employed at Morgan Importing.**
- **The receiving clerks employed at Morgan Importing.**
- **The stores where the purchasing agents buy items.**
- **The purchases themselves at the store.**
- **The shippers used to ship the purchases to Morgan Importing.**
- **The shipments made by the shippers.**
- **The receipt of the shipments at Morgan Importing by the receiving clerks.**

James Morgan and his wife Susan often make purchases themselves while traveling to various countries (and therefore, even though they are not purchasing agents per se, they need to be listed as purchasing agents in the system when data is entered). Purchases may be made at the stores themselves or by Internet or phone purchases. Sometimes several items are purchased from a store on a single visit, but do not assume that all of the items are placed on the same shipment. Shipping must track each item in a shipment and assign a separate insurance value to each item. Receiving must track the arrival date and time of a shipment, who accepted receipt of the shipment on behalf of Morgan Importing, and the condition of each item upon receipt.

A. Using your knowledge, create a data model for the Morgan Importing procument information system. Name each entity, describe its type, and indicate all attributes and identifiers. Name each relationship, describe its type, and specify minimum and maximum cardinalities.

B. List any item in your answer to A that you believe should be checked out with James Morgan and/or his employees.

[6]If you are not familiar with the concept of a procurement system, see the Wikipedia article on procurement at *http://en.wikipedia.org/wiki/Procurement*.