Homework Assignment 3 for CSCI-GA-2433 Database System

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Abstract

The exercises are from textbook Fundamental of database systems, seventh edition.

1 Question1, exercise 3.19

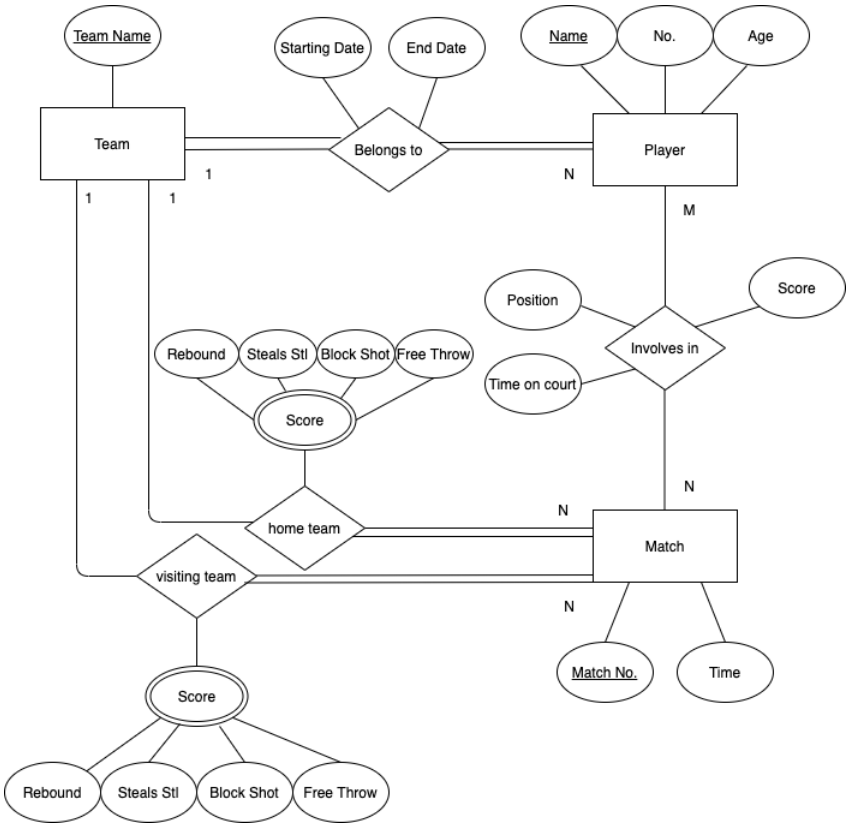
Consider the ER diagram in Figure 3.21, which shows a simplified schema for an airline reservations system. Extract from the ER diagram the requirements and constraints that produced this schema. Try to be as precise as possible in your requirements and constraints specification.
1.Each weak entity FLIGHT_LEG is total participant in relation ARRIVAL_AIRPORT, and it is total participant in relation DEPARTURE_AIRPORT,since it must have an airport to depart and to arrive. Meanwhile, every AIRPORT can take many FLIGHT_LEG to depart and arrive, and not necessarily take any FLIGHT_LEG, hence it is a 1:N relationship.
2. The weak entity FLIGHT_LEG,with the partial key Leg_no, has identifying relationship to its owner entity FLIGHT.
3. The weak entity FARE, whose partial key is Code, has identifying relationship with its owner entity FLIGHT.
4. The weak entity LEG_INSTANCE is an INSTANCE_OF(identifying relationship) FLIGHT_LEG. The LEG_INSTANCE has attributes number of available seats and date(partial key). Meanwhile, the schedule departure time and schedule arrival time are also preserved.
5. The weak entity SEAT is RESERVATION(identifying relationship) of LEG_INSTANCE, with information seat number, customer name and cell phone number.
6. The entity AIRPLANE is in TYPE relationship with AIRPLANE_TYPE, which means each AIRPLANE has an AIRPLANE_TYPE. Meanwhile, the entity AIRPLANE has key attribute Airplane_id and attribute Total_no_of_seats. The entity AIRPLANE_TYPE has key attribute Type_name and attributes Company and Max_seats. The entity AIRPLANE_TYPE has relationship CAN_LAND(many-to-many) with AIRPORT. The entity AIRPORT has key attribute Airport_code, and attributes City, State, and Name. 7. Each entity FLIGHT has Number as

its key attribute, meanwhile, the other attributes are airline and weekdays.
8.The weak entity Fare has code as its partial key attribute. Fare is associated with FLIGHT by an identifying relationship FARES.
9. Each LEG_INSTANCE has two legs, one ARRIVES and one DEPARTS. Each leg has a time. One leg has the departure information of departing at a time and at an airport. The other leg has the arrival information of arriving at a time and at an airport.
10. Each LEG_INSTANCE has number of available seats and date as attributes. Meanwhile, LEG_INSTANCE has relationship with seat(where the seat number is informed) by RESERVATION associated with customer name and cell phone number.
11. Each Airport is unique, distinguished by its key attribute: Airport_code. Meanwhile, Airport has other attributes, such as City, State, and Name.
12. Similarly, each AIRPLANE_TYPE has key attribute Type_name and other attributes, such as Company and Max_seats.

2 Question, exercise 3.22

A database is being constructed to keep track of the teams and games of a sports league. A team has a number of players, not all of whom participate in each game. It is desired to keep track of the players participating in each game for each team, the positions they played in that game, and the result of the game. Design an ER schema diagram for this application, stating any assumptions you make. Choose your favorite sport (e.g., soccer, baseball, football).

ER

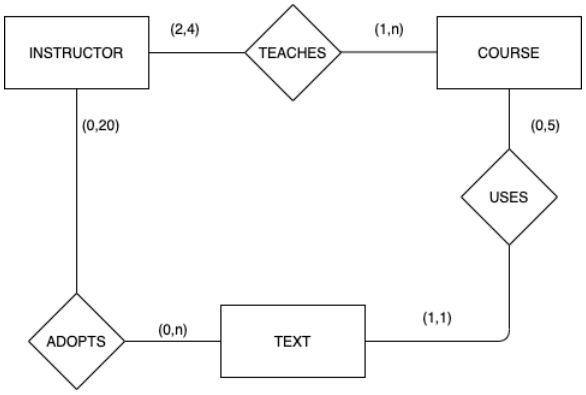


3 Question, exercise 3.25

Consider the ER diagram in Figure 3.24. Assume that a course may or may not use a textbook, but that a text by definition is a book that is used in some course. A course may not use more than five books. Instructors teach from two to four courses. Supply (min, max) constraints on this diagram. State clearly any additional assumptions you make. If we add the relationship ADOPTS, to indicate the textbook(s) that an instructor uses for a course, should it be a binary relationship between INSTRUCTOR and TEXT, or a ternary relationship among all three entity types? What (min, max) constraints would you put on the relationship? Why?

Assumption: 1. a course can be taught by multiple instructors, and by at least one instructor.
2.No two courses use the same textbook.
3. Every instructor is teaching courses.
4. A course does not necessarily use a textbook.

If we add the relationship ADOPTS, to indicate the textbook(s) that an instructor uses for a course, it should be binary relationship between INSTRUCTOR and TEXT,(even though it still can be represented as ternary, but redundant; since the ternary relationship can be inferred from the three binary relationships).



ER

Since every instructor can teach at most 4 courses, and each course can at most have 5 textbooks, hence it is 20 for the maximum between INSTRUCTOR and ADOPT.
Since every instructor does not necessarily use a textbook for any course, hence it is 0 for minimum between INSTRUCTOR and ADOPT.
Since a textbook might not be recommended by any instructor, and can be recommended by multiple instructors(a course can be taught by multiple instructors), hence it is (0,n) between INSTRUCTOR and ADOPT.

4 Question, exercise 3.30

3.30. Illustrate the UML diagram for Exercise 3.16. Your UML design should observe the following requirements:

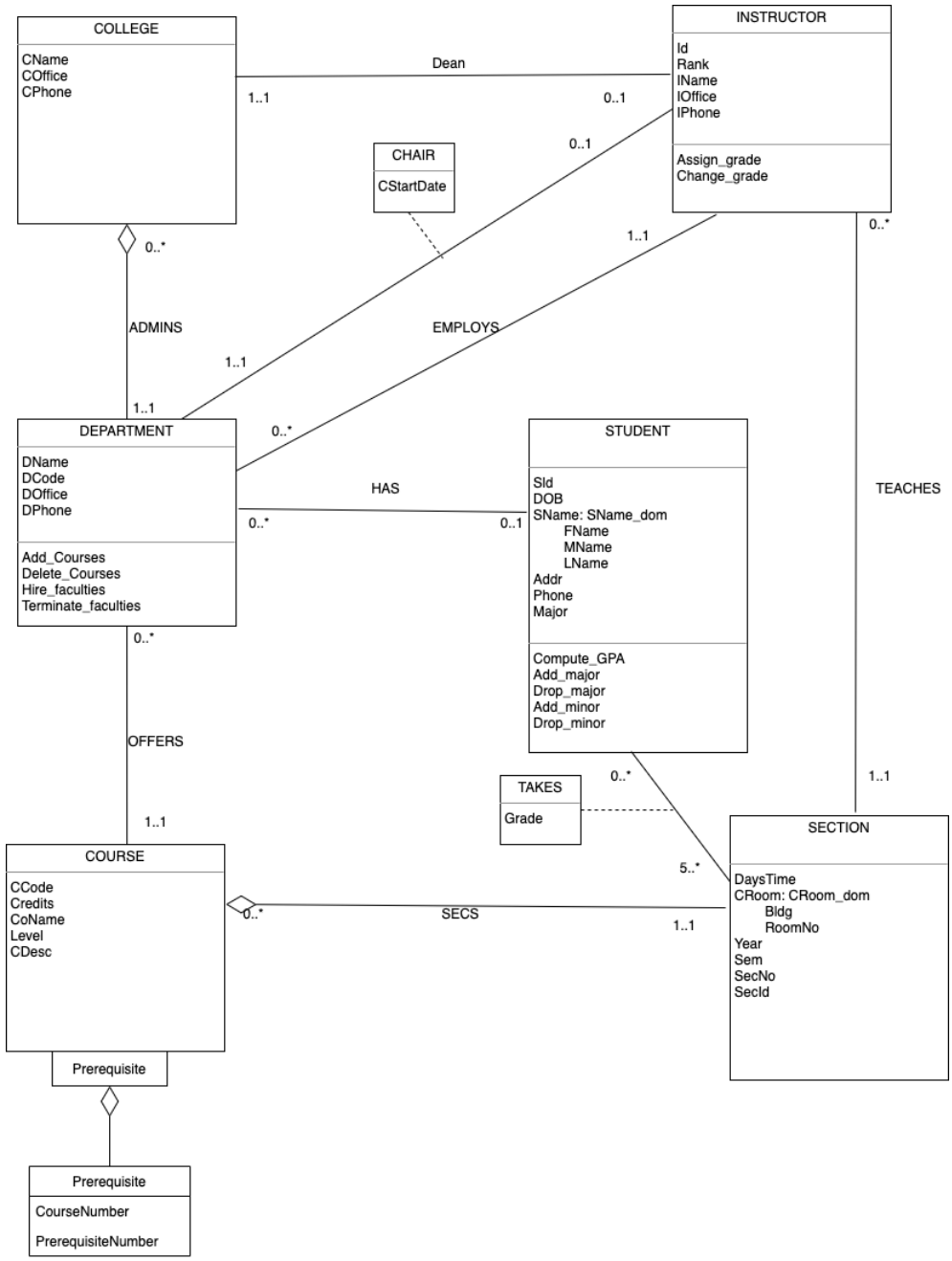
a. A student should have the ability to compute his/her GPA and add or drop majors and minors.

b. Each department should be able to add or delete courses and hire or terminate faculty.

c. Each instructor should be able to assign or change a student's grade for a course.

Note: Some of these functions may be spread over multiple classes.

UML


COLLEGE
CName
COffice
CPhone
Dean
1..1
0..1
INSTRUCTOR
Id
Rank
IName
IOffice
IPhone
Assign_grade
Change_grade
CHAIR
CStartDate
0..1
0..*
1..1
0..*
ADMINS
EMPLOYS
1..1
1..1
DEPARTMENT
DName
DCode
DOffice
DPhone
Add_Courses
Delete_Courses
Hire_faculties
Terminate_faculties
0..*
HAS
0..*
0..1
STUDENT
SId
DOB
SName: SName_dom
FName
MName
LName
Addr
Phone
Major
Compute_GPA
Add_major
Drop_major
Add_minor
Drop_minor
TEACHES
0..*
OFFERS
1..1
TAKES
Grade
0..*
1..1
5..*
SECTION
DaysTime
CRoom: CRoom_dom
Bldg
RoomNo
Year
Sem
SecNo
SecId
COURSE
CCode
Credits
CoName
Level
CDesc
0..*
SECS
1..1
Prerequisite
Prerequisite
CourseNumber
PrerequisiteNumber

5 Question, exercise 4.19

4.19. Identify all the important concepts represented in the library database case study described below. In particular, identify the abstractions of classification (entity types and relationship types), aggregation, identification, and specialization/generalization. Specify (min, max) cardinality constraints whenever possible. List details that will affect the eventual design but that have no bearing on the conceptual design. List the semantic constraints separately. Draw an EER diagram of the library database.

Case Study: The Georgia Tech Library (GTL) has approximately 16,000 members, 100,000 titles, and 250,000 volumes (an average of 2.5 copies per book). About 10% of the volumes are out on loan at any one time. The librarians ensure that the books that members want to borrow are available when the members want to borrow them. Also, the librarians must know how many copies of each book are in the library or out on loan at any given time. A catalog of books is available online that lists books by author, title, and subject area. For each title in the library, a book description is kept in the catalog; the description ranges from one sentence to several pages. The reference librarians want to be able to access this description when members request information about a book. Library staff includes chief librarian, departmental associate librarians, reference librarians, check-out staff, and library assistants.

Books can be checked out for 21 days. Members are allowed to have only five books out at a time. Members usually return books within three to four weeks. Most members know that they have one week of grace before a notice is sent to them, so they try to return books before the grace period ends. About 5% of the members have to be sent reminders to return books. Most overdue books are returned within a month of the due date. Approximately 5% of the overdue books are either kept or never returned. The most active members of the library are defined as those who borrow books at least ten times during the year. The top 1% of membership does 15% of the borrowing, and the top 10% of the membership does 40% of the borrowing. About 20% of the members are totally inactive in that they are members who never borrow.

To become a member of the library, applicants fill out a form including their SSN, campus and home mailing addresses, and phone numbers. The librari-

ans issue a numbered, machine-readable card with the member's photo on it. This card is good for four years. A month before a card expires, a notice is sent to a member for renewal. Professors at the institute are considered automatic members. When a new faculty member joins the institute, his or her information is pulled from the employee records and a library card is mailed to his or her campus address. Professors are allowed to check out books for three-month intervals and have a two-week grace period. Renewal notices to professors are sent to their campus address.

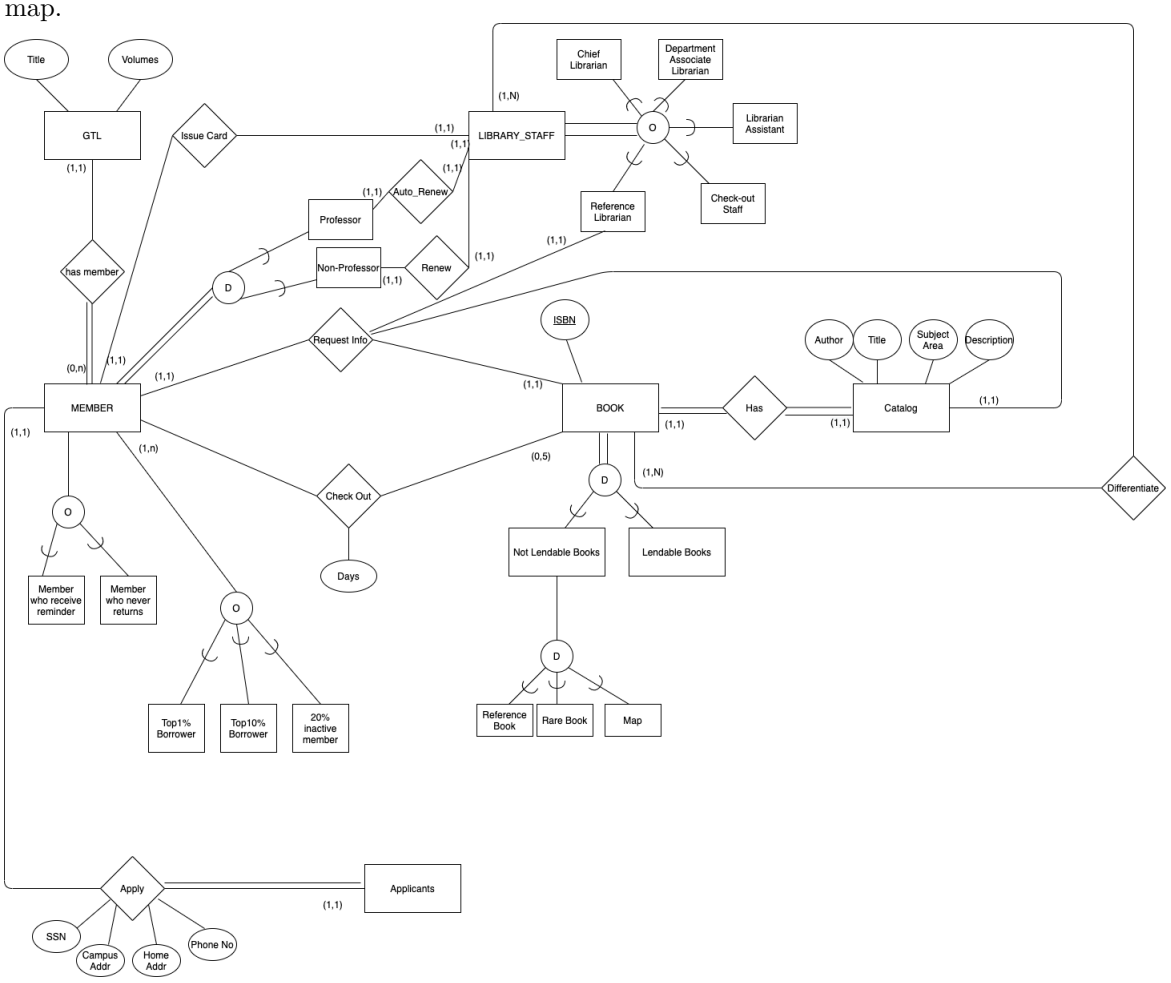
The library does not lend some books, such as reference books, rare books, and maps. The librarians must differentiate between books that can be lent and those that cannot be lent. In addition, the librarians have a list of some books they are interested in acquiring but cannot obtain, such as rare or out-of-print books and books that were lost or destroyed but have not been replaced. The librarians must have a system that keeps track of books that cannot be lent as well as books that they are interested in acquiring. Some books may have the same title; therefore, the title cannot be used as a means of identification. Every book is identified by its International Standard Book Number (ISBN), a unique international code assigned to all books. Two books with the same title can have different ISBNs if they are in different languages or have different bindings (hardcover or softcover). Editions of the same book have different ISBNs.

The proposed database system must be designed to keep track of the members, the books, the catalog, and the borrowing activity.

The class(entity) GTL is aggregated by(an aggregation of) its attributes: member, title, volumes. Since we are going to analyze MEMBER as entity later on, we can take member out from the attribute of GTL, and generate MEMBER as an entity, with HAS_MEMBER as association(relationship) between class GTL and class MEMBER.
The class(entity) CATALOG is an aggregation of (has attributes): author, title, subject area, and description. The super-class LIBRARY_STAFF has specialization of: chief librarian, departmental associate librarian, reference librarian, check-out staff, and library assistants. The association among the sub-classes can be overlapping. In addition, the reference librarian can have access the description of a book when members request information.
The MEMBER can be specialized into sub-classes: members who receive reminders and members who never return books.The MEMBER can also be specialized into sub-classes: top 1 percent borrower, top 10 percent borrower, and 20 percent inactive members. The class MEMBER also can be specialized as: professor and non-professor. The subclass professor has its unique association with librarian on renewing and checking out.
The class APPLICANT has association with the class MEMBER. An applicant can apply with SSN, campus address, home address and phone number to become a member.
The borrowing activity is happening between class MEMBER and class BOOK. A member can at most check out 5 books at a time.
Moreover, the class BOOK is disjointedly specialized into sub-classes as NOT

LEND-ABLE BOOK and LEND-ABLE BOOK. The NOT LEND-ABLE BOOK is again disjointedly specialized into sub-classes: reference book, rare book, and map.

EER



6 Question, exercise 4.21

4.21. Figure 4.12 shows an example of an EER diagram for a small-private-airport database; the database is used to keep track of airplanes, their owners, airport employees, and pilots. From the requirements for this database, the following information was collected: Each AIRPLANE has a registration number [Reg#], is of a particular plane type [OF_TYPE], and is stored in a particular hangar [STORED_IN]. Each PLANE_TYPE has a model number [Model], a capacity [Capacity], and a weight [Weight]. Each HANGAR has a number [Number], a capacity [Capacity], and a location [Location]. The database also keeps track of the OWNERs of each plane [OWNS] and the EMPLOYEEs who have maintained the plane [MAINTAIN]. Each relationship instance in OWNS relates an AIRPLANE to an OWNER and includes the purchase date [Pdate]. Each relationship instance in MAINTAIN relates an EMPLOYEE to a service record [SERVICE]. Each plane undergoes service many times; hence, it is related by [PLANE_SERVICE] to a number of SERVICE records. A SERVICE record includes as attributes the date of maintenance [Date], the number of hours spent on the work [Hours], and the type of work done [Work_code]. We use a weak entity type [SERVICE] to represent airplane service, because the airplane registration number is used to identify a service record. An OWNER is either a person or a corporation. Hence, we use a union type (category) [OWNER] that is a subset of the union of corporation [CORPORATION] and person [PERSON] entity types. Both pilots [PILOT] and employees [EMPLOYEE] are subclasses of PERSON. Each PILOT has specific attributes license number [Lic_num] and restrictions [Restr]; each EMPLOYEE has specific attributes salary [Salary] and shift worked [Shift]. All PERSON entities in the database have data kept on their Social Security number [Ssn], name [Name], address [Address], and telephone number [Phone]. For CORPORATION entities, the data kept includes name [Name], address [Address], and telephone number [Phone]. The database also keeps track of the types of

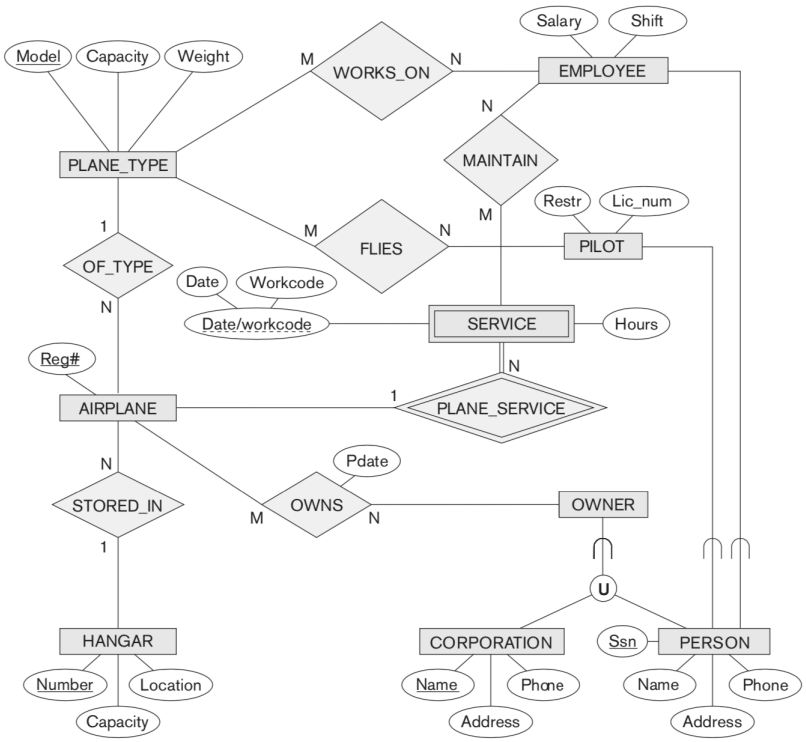
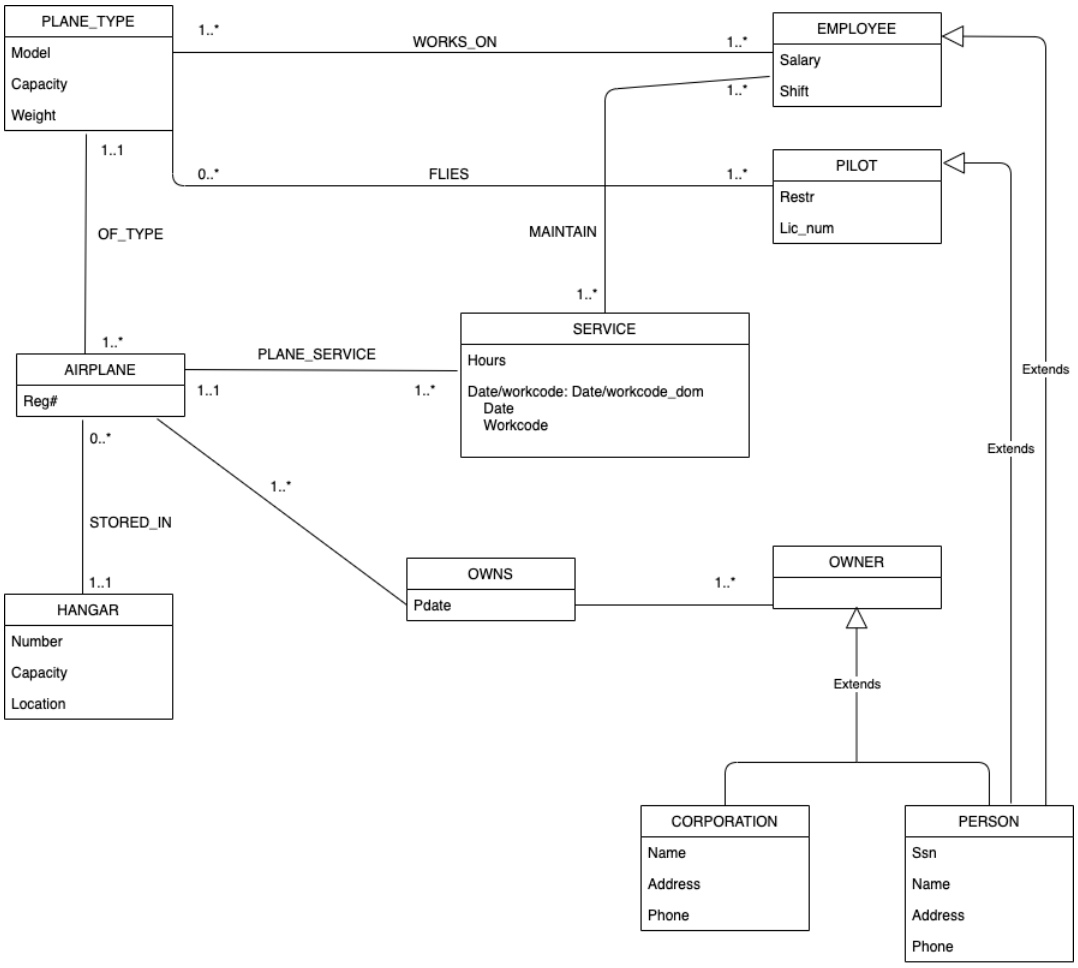


Figure 4.12
EER schema for a SMALL_AIRPORT database.

planes each pilot is authorized to fly [FLIES] and the types of planes each employee can do maintenance work on [WORKS_ON]. Show how the SMALL_AIRPORT EER schema in Figure 4.12 may be represented in UML notation. (*Note*: We have not discussed how to represent categories (union types) in UML, so you do not have to map the categories in this and the following question.)

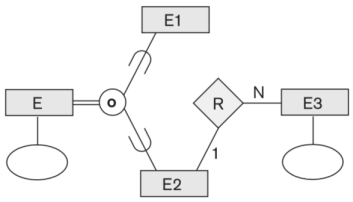
UML


PLANE_TYPE
Model
Capacity
Weight
1..*
WORKS_ON
1..*
EMPLOYEE
Salary
Shift
1..*
1..1
0..*
FLIES
1..*
PILOT
Restr
Lic_num
OF_TYPE
MAINTAIN
1..*
1..*
SERVICE
Hours
Date/workcode: Date/workcode_dom
Date
Workcode
AIRPLANE
Reg#
PLANE_SERVICE
1..1
1..*
Extends
Extends
0..*
1..*
STORED_IN
1..1
HANGAR
Number
Capacity
Location
OWNS
Pdate
1..*
OWNER
Extends
CORPORATION
Name
Address
Phone
PERSON
Ssn
Name
Address
Phone

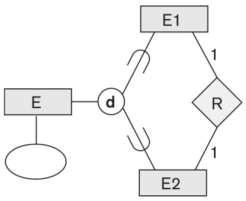
7 Question, exercise 4.26

4.26. Which of the following EER diagrams is/are incorrect and why? State clearly any assumptions you make.

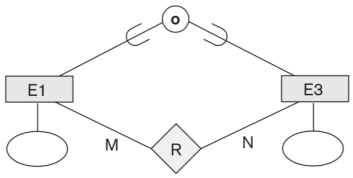
a.



b.



c.



The graph a and b are correct. The graph c is incorrect.
In graph c, in order to express the overlapping association in specialization, we need a class(an entity) as a super-class to participate. However, in graph c, only sub-classes E1 and E3 are shown.