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Database Systems - Introduction to Databases and Data Warehouses

(Instructors Manual)

BRIEF CONTENTS

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CHAPTER 1 – Introduction

KEY CONCEPTS

The goal of this chapter is to provide a preliminary overview of the basic terms and concepts related to the design and use of database systems. An initial introduction of the following topics is provided:

- Data and Information
- Metadata
- Database System (Information System)
    - Database
    - Database Management System (DBMS)
    - Front-End Application
- End Users
    - Direct Interaction
    - Indirect Interaction
- Steps in the Development of Database Systems
    - Requirements Collection, Definition, and Visualization
    - Database Modeling
    - Database Implementation
    - Developing Front-End Applications
    - Database Deployment
    - Database Use
    - Database Administration and Maintenance
- The Next Version of the Database
- Database Scope
- People involved with Database Systems
    - Database Analysts, Designers, and Developers
    - Front-End Applications Analysts and Developers
    - Database Administrators
    - Database End Users
- Operational Information
- Operational Databases
- Analytical Information
- Analytical Databases

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Chapter 1 - ANSWERS (Review Questions)

Q1.1 *Give several examples of instances of data.*

- Date describing a midterm exam score for a student taking a class
- Data describing a blood type of a patient
- Data describing weight of a football player

Q1.2 *Give several examples of converting data to information.*

- Calculating student's final grade in a class, based on his scores throughout a class.
- Looking up patient's blood type data before administering transfusion
- Calculating average player's weight for a football team

Q1.3 *Create your own example that shows a collection of data, first without the metadata and then with the metadata.*

111	John	Doe	1/1/1975
222	Jane	Smith	3/16/1982
333	Fred	Williams	5/7/1970
444	Sarah	Jones	9/1/1985

DoctorID	**DoctorFName**	**DoctorLName**	**DoctorDOB**
111	John	Doe	1/1/1975
222	Jane	Smith	3/16/1982
333	Fred	Williams	5/7/1970
444	Sarah	Jones	9/1/1985

Q1.4 *Describe the relationship between the database and DBMS.*

For example, the relationship between a DBMS and a database is similar to the relationship between the presentation software (such as MS PowerPoint) and a presentation. Presentation software is used to create a presentation, insert content in a presentation, conduct a presentation, and change or delete content in a presentation. Similarly, a DBMS is used to create a database, insert the data in the database, retrieve the data from the database, and change or delete the data in the database.

Q1.5 *What are the main components of a database system?*

The three main components of a database system are the database, the DBMS and the front-end applications.

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Q1.6 *Give an example of an indirect use of a database system.*

A user selecting a seat for a flight using an airport check-in kiosk.

Q1.7 *What are the steps in the development of a database system?*

- Requirements Collection, Definition, and Visualization
- Database Modeling
- Database Implementation
- Developing Front-End Applications
- Database Deployment
- Database Use
- Database Administration and Maintenance

Q1.8 *Explain the iterative nature of the database requirements collection, definition, and visualization process.*

In most database projects the initial collection of database requirements differs from the final set, both in size (by being smaller) and content. Therefore, during database development requirements are modified and new requirements are added. This may happen several times throughout database development process which makes the requirements stage an iterative process.

Q1.9 *What is the purpose of conceptual database modeling?*

Visualization of the database requirements.

Q1.10 *What is the purpose of logical database modeling?*

Creation of the database model that is implementable by the DBMS software

Q1.11 *Briefly describe the process of database implementation.*

During this process the database model is implemented as an actual database that is initially empty. Database implementation is a straightforward process that involves database developers using the DBMS functionalities and capabilities to implement the database model as an actual functioning database, much in the same way a construction crew uses construction equipment to implement a blueprint for a building as an actual building.

Q1.12 *Briefly describe the process of developing the front-end applications.*

The process of developing front-end applications refers to designing and creating applications for indirect use of the database by the end users. The front-end applications are based on the database model and the requirements specifying the front-end functionalities of the system needed by the end users. Front-end applications usually contain interfaces, such as forms and reports, accessible via navigation mechanisms, such as menus.

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Q1.13 *What takes place during database deployment?*

Database deployment refers to releasing the database system (i.e., the database and its front-end applications) for use by the end users. Typically, this step also involves populating the implemented database with the initial set of data.

Q1.14 *What four data operations constitute database use?*

- Data Insertion
- Data Modification
- Data Deletion
- Data Retrieval

Q1.15 *Give examples of database administration and maintenance activities.*

Database administration and maintenance activities include dealing with technical issues, such as providing security for the information contained in the database, ensuring sufficient hard-drive space for the database content, and implementing backup and recovery procedures.

Q1.16 *What are the similarities and differences between the development of the initial and subsequent versions of the database?*

As with the initial version of the database system, the development of subsequent versions of the database system will start with the requirements collection, definition, and visualization step. Unlike with the initial version, in the subsequent versions not all requirements will be collected from scratch. Original requirements provide the starting point for additions and alterations. Many of the additions and modifications result from observations and feedback by the end users during the use of the previous version, indicating the ways in which the database system can be improved or expanded. Other new requirements may stem from changes in the business processes that the database system supports, or changes in underlying technology.

Q1.17 *How does the scope of the database influence the development of the database system?*

The difference in the scope of databases is reflected in the size, complexity, and cost in time and resources required for each of the steps in the development of a database system.

Q1.18 *What are the main four categories of people involved with database projects?*

- Database Analysts, Designers, and Developers
- Front-End Applications Analysts and Developers
- Database Administrators
- Database End Users

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Q1.19 *What is the role of database analysts?*

Database analysts conduct the requirements collection, definition, and visualization stage of a database project.

Q1.20 *What is the role of database designers?*

Database designers (database modelers or architects) conduct the database modeling stage of a database project.

Q1.21 *What is the role of database developers?*

Database developers implement the database model as a functioning database using the DBMS software.

Q1.22 *What is the role of front-end application analysts?*

Front-end application analysts collect and define requirements for front-end applications.

Q1.23 *What is the role of front-end application developers?*

Front-end application developers create the front-end applications based on the requirements defined by the front-end application analysts.

Q1.24 *How is the term "quality of a database system" related to the end users?*

The quality of a database system is measured by how quickly and easily it can provide the accurate and complete information needed by its end users.

Q1.25 *Give an example of operational (transactional) information.*

Information resulting from a customer purchasing a book at an on-line book store.

Q1.26 *Give an example of analytical information.*

Information showing a pattern of sales for an online book store, such as the ratios of fiction vs. non-fiction book purchases for male and female customers in the past twelve quarters.

Q1.27 *List several relational DBMS software packages.*

Oracle, MySQL, Microsoft SQL Server, PostgreSQL, IBM DB2, Teradata.

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CHAPTER 2 – Database Requirements and ER Modeling

KEY CONCEPTS

The goal of this chapter is to provide comprehensive coverage of entity-relationship (ER) modeling - a conceptual method for visualizing and structuring user database requirements.

The following topics related to ER modeling for are covered:

- Visualizing and Structuring the Database Requirements with ER Modeling
- ER Modeling Components
    - Entities
        - Regular
        - Weak
        - Associative
    - Relationships
        - Cardinality Constraints
            - Maximum Cardinality - One or Many
            - Minimum Cardinality (Participation) – Optional or Mandatory
        - Degrees:
            - Binary
            - Unary
            - Ternary
        - Maximum Cardinality-Wise
            - 1:M
            - M:N
            - 1:1
        - Identifying Relationships
        - Exact Minimum and Maximum Cardinalities
        - Relationship Roles
        - Multiple Relationships between the Same Entities
    - Attributes
        - Regular
        - Unique
        - Multiple Unique (Candidate Keys)
        - Composite
        - Composite Unique
        - Derived
        - Multivalued
        - Optional
        - Relationship Attributes

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Chapter 2 - ANSWERS (Review Questions)

Q2.1 *What is the purpose of ER modeling?*

ER modeling is a conceptual database modeling method. It enables the structuring and organizing of the requirements collection process and provides a way to graphically represent the requirements.

Q2.2 *What are the basic ER modeling constructs?*

Entities (with their attributes) and relationships.

Q2.3 *What is a unique attribute?*

An attribute whose value is different for each entity instance.

Q2.4 *What is depicted by cardinality constraints?*

Cardinality constraints depict how many instances of one entity can be associated with instances of another entity

Q2.5 *What are the four possible cardinality constraints?*

- Mandatory Many
- Optional Many
- Mandatory One
- Optional One

Q2.6 *What are the three types of relationships (maximum cardinality-wise)?*

- One-to-one relationship (1:1)
- One-to-many relationship (1:M)
- Many-to-many relationship (M:N)

Q2.7 *What is a composite attribute?*

An attribute that is composed of several attributes.

Q2.8 *What are candidate keys?*

Multiple unique attributes of the same entity.

Q2.9 *What is a multivalued attribute?*

An attribute for which instances of an entity can have multiple values.

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Q2.10 *What is a derived attribute?*

An attribute whose value will not be permanently stored in a database.

Q2.11 *What is an optional attribute?*

An attribute that is allowed to not have a value

Q2.12 *How are exact minimum and maximum cardinalities depicted in a relationship?*

By pairs of numbers in parentheses placed on the relationship lines. The number closest to the open parenthesis indicates minimum cardinality. The second number, the number closest to the closed parenthesis, indicates maximum cardinality.

Q2.13 *What is a binary relationship?*

A relationship that involves two entities.

Q2.14 *What is a unary relationship?*

A relationship involving one entity in a relationship with itself.

Q2.15 *What is a weak entity?*

A construct in an ER diagram used to depict entities that do not have a unique attribute of their own.

Q2.16 *What is an associative entity?*

An ER diagram construct used as an alternative way of depicting M:N relationships.

Q2.17 *What is a ternary relationship?*

A relationship involving three entities

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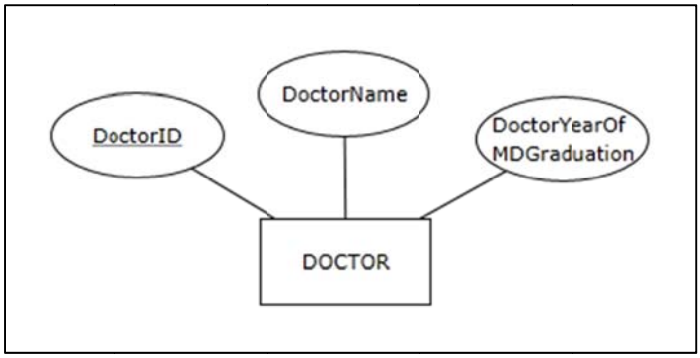
Chapter 2 - ANSWERS (Exercises)

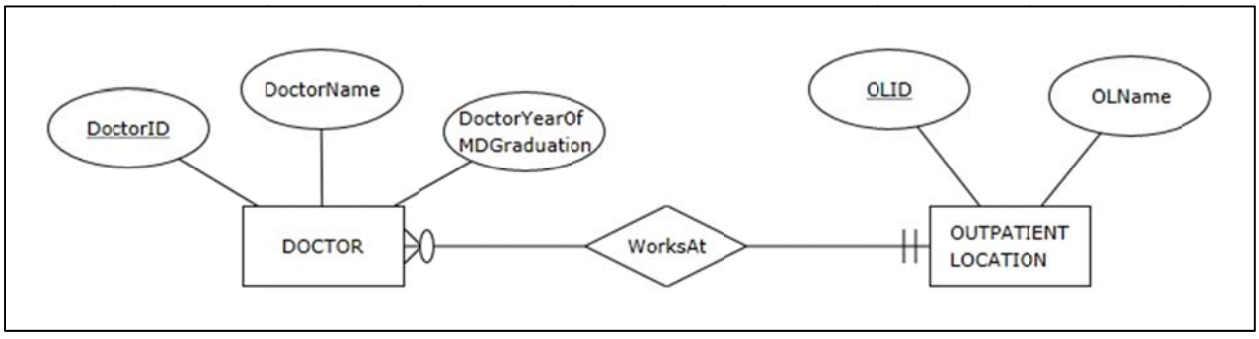
E2.1 *Create an example of an entity with several attributes.*



E2.2 *Create requirements and the ER diagram for a scenario with two entities (both with several attributes) involved in the following relationship:*

E2.2a *1:M relationship, where participation on the 1 side is mandatory and participation on the M side is optional.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at exactly one outpatient location and each outpatient location can have between none (rehab and minor health issues only) and many doctors working at it.



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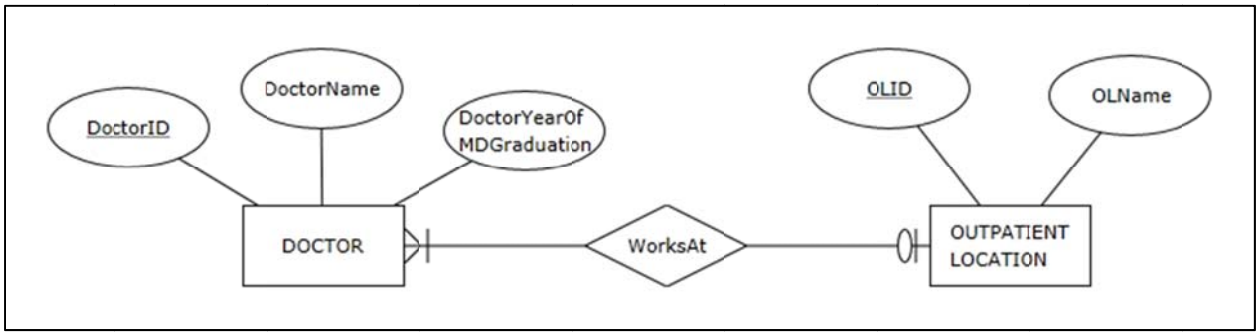
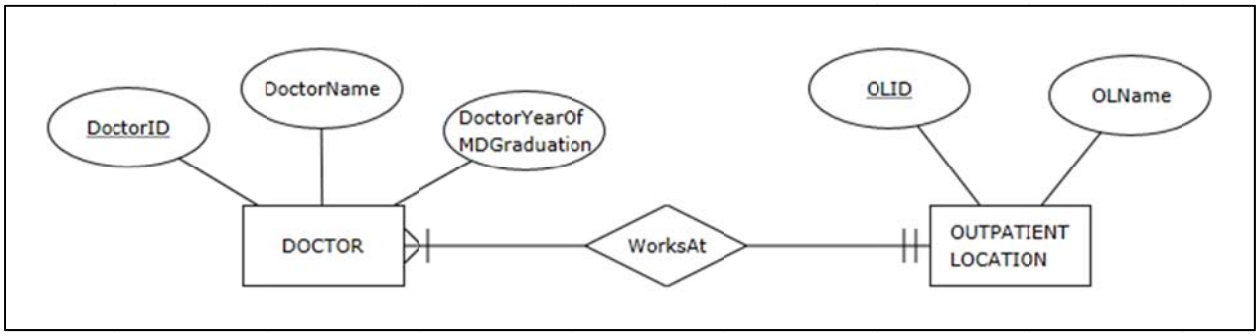
E2.2b *1:M relationship, where participation on the 1 side is optional and participation on the M side is mandatory.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at either one outpatient location or at none (strictly working in the main hospital) and each outpatient location must have at least one but can have many doctors working at it



E2.2c *1:M relationship, where participation on both sides is mandatory.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at exactly one outpatient location and each outpatient location must have at least one but can have many doctors working at it



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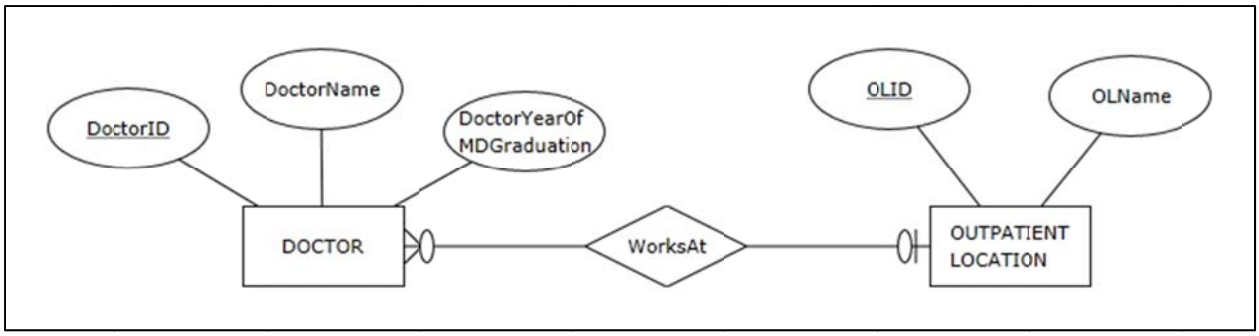
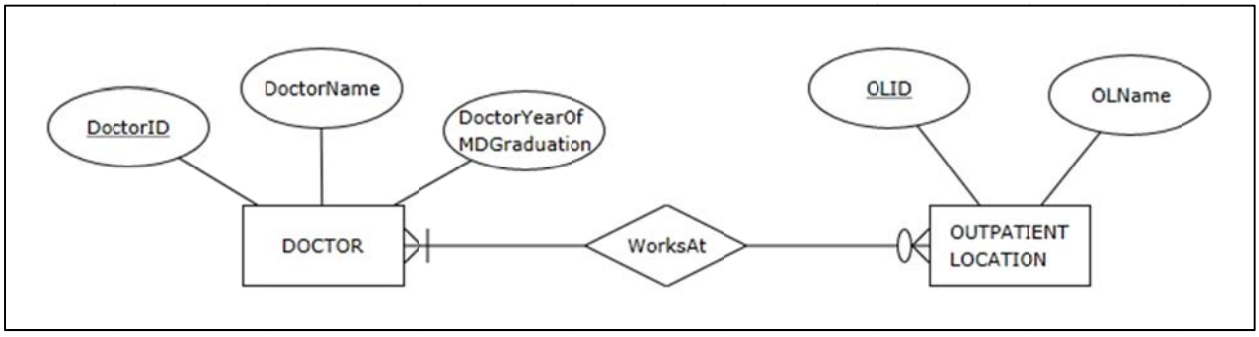
E2.2d *1:M relationship, where participation on both sides is optional.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at either one outpatient location or at none (strictly working in the main hospital) and each outpatient location can have between none (rehab and minor health issues only) and many doctors working at it



E2.2e *M:N relationship, where participation on one side is mandatory and participation on the other side is optional.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at between none (strictly working in the main hospital) and many outpatient locations and each outpatient location must have at least one but can have many doctors working at it



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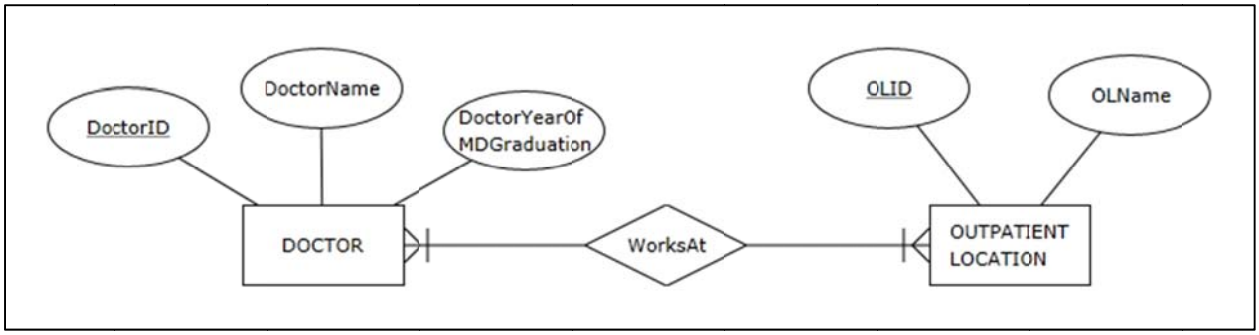
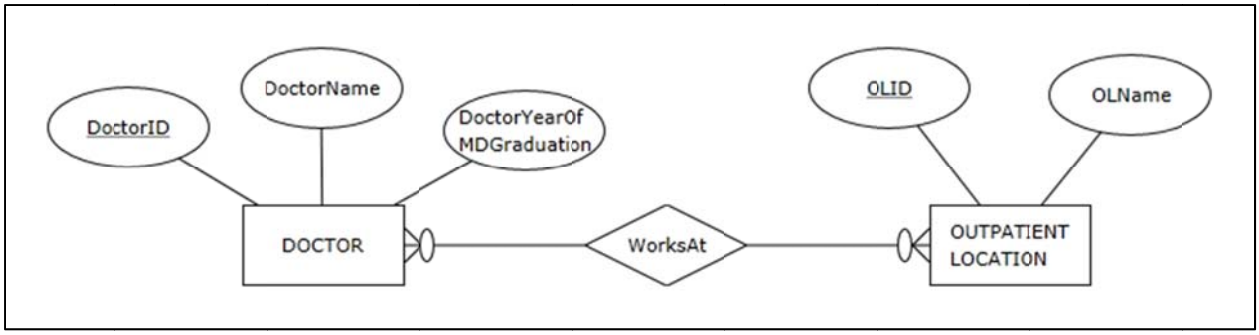
E2.2f *M:N relationship, where participation on both sides is mandatory.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at between one and many outpatient locations and each outpatient location must have at least one but can have many doctors working at it



E2.2g *M:N relationship, where participation on both sides is optional.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at between none (strictly working in the main hospital) and many outpatient locations and each outpatient location can have between none (rehab and minor health issues only) and many doctors working at it



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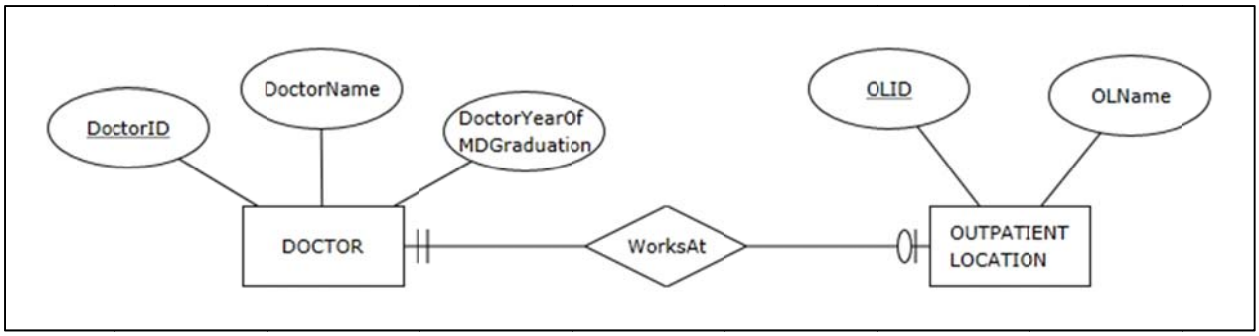
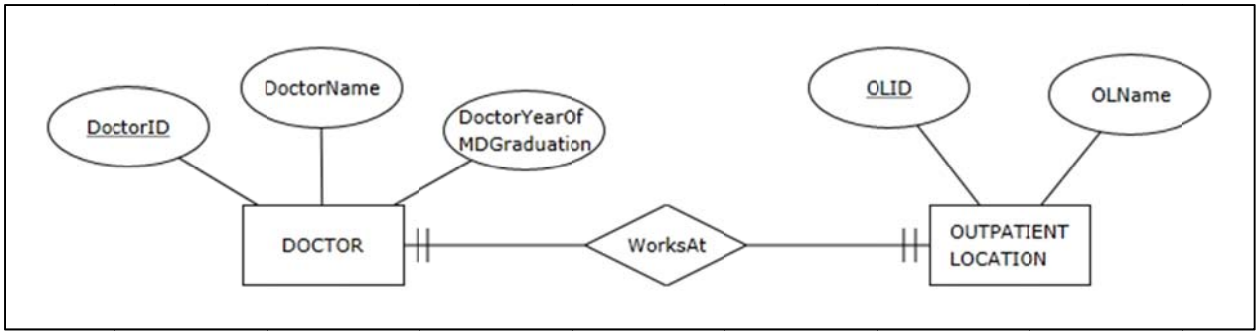
E2.2h *1:1 relationship, where participation on one side is mandatory and participation on the other side is optional.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at either one outpatient location or at none (strictly working in the main hospital) and each outpatient location has exactly one doctor working at it



E2.2i *1:1 relationship, where participation on both sides is mandatory.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at exactly one outpatient location and each outpatient location has exactly one doctor working at it



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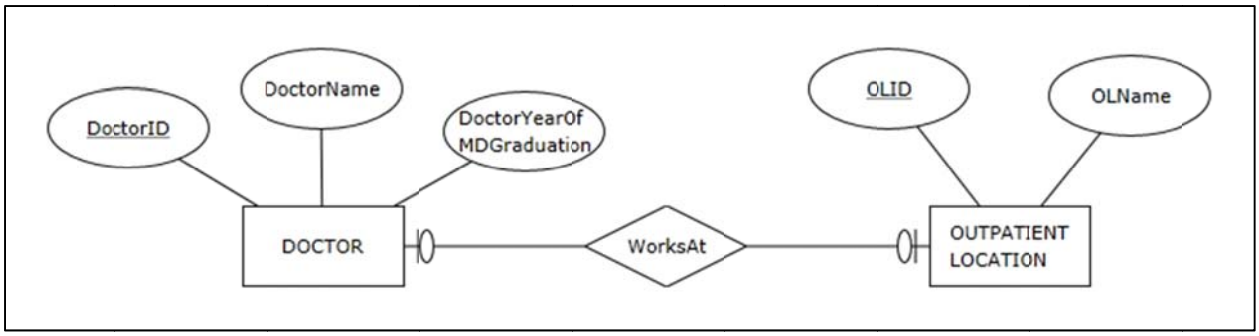
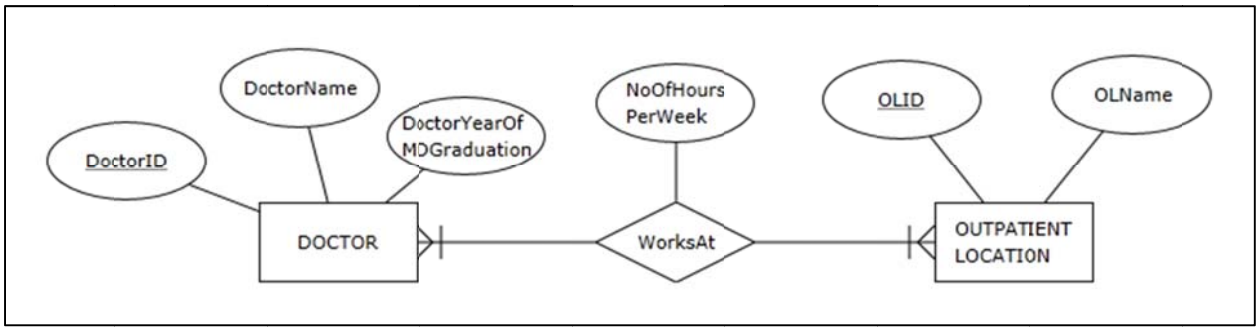
E2.2j *1:1 relationship, where participation on both sides is optional.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at either one outpatient location or at none (strictly working in the main hospital) and each outpatient location can have between none (rehab and minor health issues only) and one doctor working at it



E2.3 *Create requirements and the ER diagram for a scenario with two entities (both with several attributes) involved in a many-to-many relationship that has a relationship attribute.*

- A health care organization keeps track of its doctors and outpatient locations
- For each doctor it keeps track of the DoctorID (unique), DoctorName, and DoctorYearOfMDGraduation (year of graduating from medical school)
- For each outpatient location it keeps track of the OLID (unique) and OLName
- Each doctor works at either between one and many outpatient locations and each outpatient location must have at least one but can have many doctors working at it
- For each occurrence of a doctor working at an outpatient location we keep track of the NoOfHoursPerWeek (number of hours per week that a doctor works at an outpatient location)



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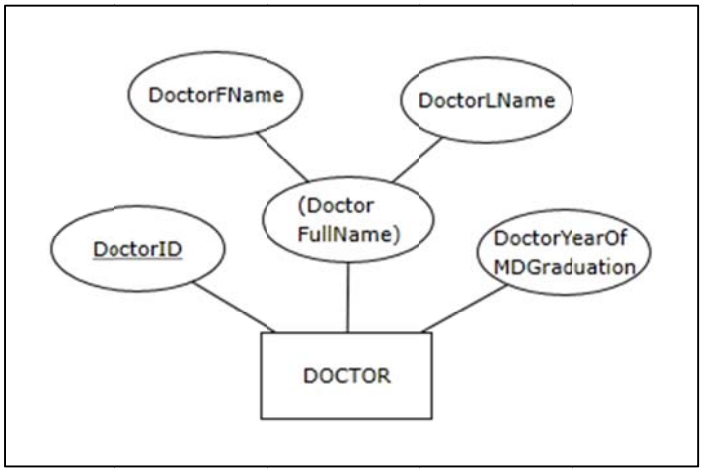
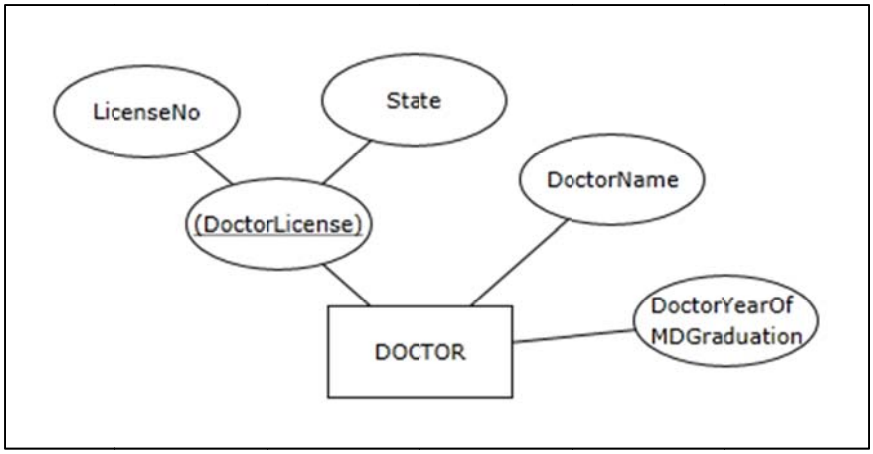
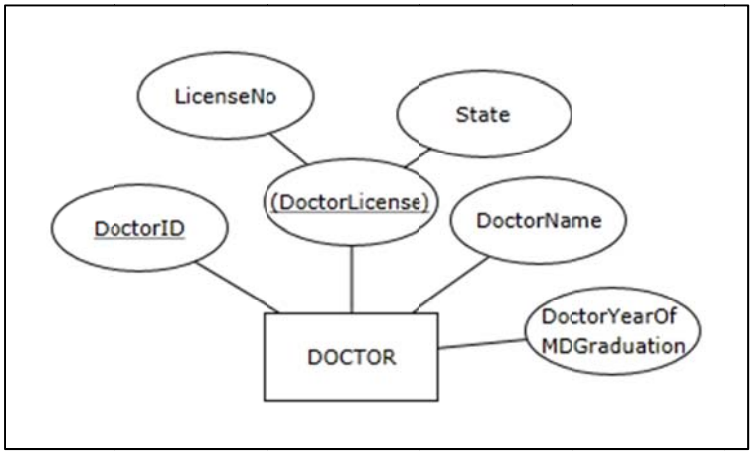
E2.4 *Create an example of an entity with a composite attribute.*



E2.5 *Create an example of an entity with a composite unique attribute.*



E2.6 *Create an example of an entity with candidate keys (multiple unique attributes).*



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