Question 1: Define the following terms and given an example for each.

1.1) Entity

An entity represents a real world object or a concept from the mini-world with an independent existence.
(or)
Something that has a separate and distinct existence and objective or conceptual reality. Example: student and professor are entities in a university's database.

1.2) Weak Entity

Entity types that do not have a key attribute of their own are called weak entities and are identified by being related to specific entities of other entity types (called identifying entity) along with their partial keys, which is one of their attributes. Weak entities have a total participation in their identifying relationship.
Example: In the given requirements of a pharmaceutical company, the entity DRUG is a weak entity because its name is linked to the pharmaceutical company that manufactures and sells it. DRUG entities have a trade name that is used to identify the drug from a plethora of other drugs sold by one company.

1.3) Attribute

Each entity in an ER diagram has particular properties that describe it. These properties are called attributes.
Example: A STUDENT entity may be described by student's name, age, date of birth and major. These four properties are its attributes.

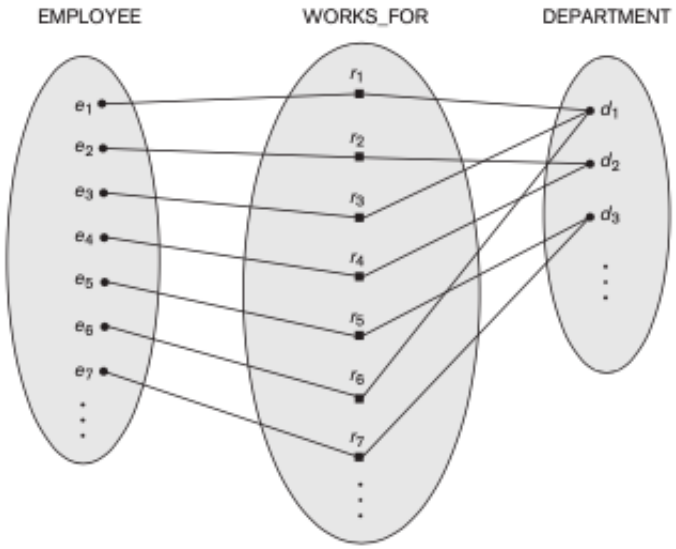
1.4) Attribute Value

Each entity has a value for each of its attribute. These attribute values become a part of the data stored in the database.
Example: Consider a STUDENT entity, e1, has four attributes: Name, Age, Date of Birth and Major; their values are 'Abhijeet Sahdev', '24', '12/19/1999', and 'Computer Science' respectively.

1.5) Relationship Instance

Consider a relationship type R for a set of n entity types, E(1) to E(n) that defines a set of associations (relationship set) between those entities. This set, R, contains relationship instances r(i)

where each r(i) associates n individual entities (e1, e2, . . . , en), and each entity e(j) in r(i) is a member of entity set E(j) with j between 1 and n.
(or)
Each relationship instance r(i) in R is an association of entities, where the association includes exactly one entity from each participating entity type.



Example:
A relationship type WORKS_FOR between the two entity types, EMPLOYEE and DEPARTMENT, which associates each employee with the department for which the employee works. Each relationship instance in the relationship set WORKS_FOR associates one EMPLOYEE entity and one DEPARTMENT entity.

1.6) Composite Attribute

These attributes can be divided into smaller sub-parts or components, which represent more basic attributes with independent meanings.
Example: Consider ADDRESS attribute of an entity such as STUDENT, EMPLOYEE, etc. This can be subdivided into Street_address, City, State, and Zip code.

1.7) Multivalued Attribute

An entity may have multiple values for a given attribute. Such attributes are multivalued. These attributes may have a lower and upper bound to constraint the number of values allowed for each individual entity.
Example: Color attribute of CAR entity can have two values if its a two-tone car. So, so a business case that has only type of cars in terms of its color, one-tone and two-tone , the attribute color can

have either one or two values.

1.8) Derived Attribute

These attributes' value can be derived from other attributes that are related to it (can be two or more) or related entities.
Example: Attributes Age and Birth_date are related attributes of a person. The value of Age can derived from knowing today's data and the value of that person's Birth_date. For entities, we can consider Number_Of_Employees in a Department(entity) as a derived attribute by counting the number of employees related to (here, working for) that department.

1.9) Key Attribute

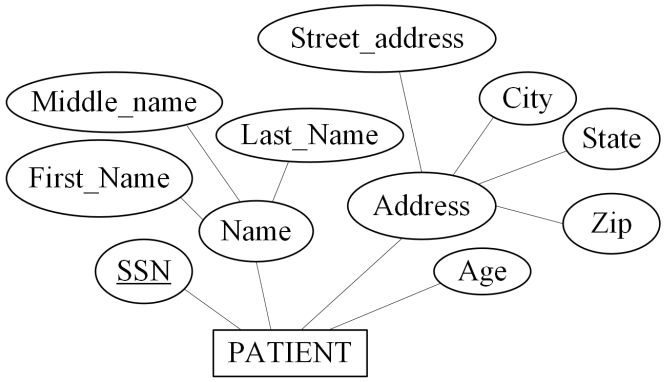
An attribute (or a collection of attributes) of an entity type that has (or have) a unique value (or their combination is unique, composite) for each individual entity in the entity set. An entity can have more than one key attribute. Moreover, each key attribute is underlined in ER diagrams.
Example: Social Security Number or SSN is unique for each Employee. For composites, consider VehicleTagNumber, which a key attribute of CAR entity with components Number and State. CAR entity may have two keys, VehicleTagNumber (Number and State) and VehicleIdentificationNumber.

1.10) Value Set (domain)

It specifies the set of values that may be assigned to a simple attribute for each individual entity. It is similar to data types available in programming languages such as string, integer, Boolean, etc.
Example: Age of EMPLOYEE should be an integer between 16 to 70.

Question 2: Draw

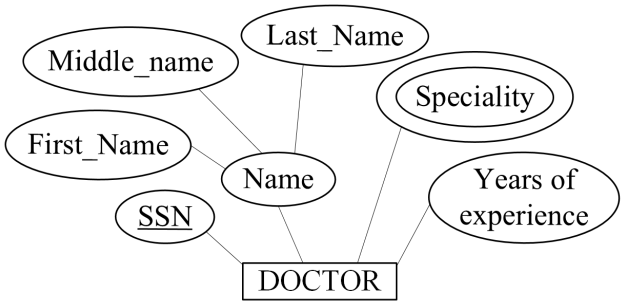
2.1) Draw a PATIENT entity with attributes. Specify all attribute types.



The attributes of PATIENT entity along with their corresponding types are as follows:

- SSN - Key attribute which is a single valued attribute.
- Name - Composite attribute which has three simple components; First_Name, Middle_Name and Last_Name.
- Address - Composite attribute with four simple components; Street_Address, City, State and Zip.
- Age - single valued attribute.

2.2) Draw a DOCTOR entity with attributes. Specify all attribute types.

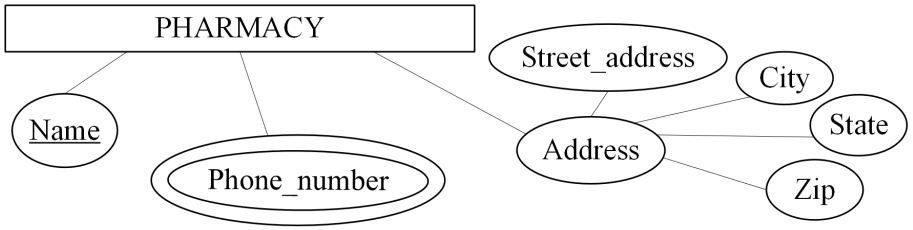


The attributes of DOCTOR entity along with their corresponding types are as follows:

- SSN - Key attribute which is a single valued attribute.

- Name - Composite attribute which has three simple components; First_Name, Middle_Name and Last_Name.
- Speciality - Multivalued attribute since a doctor can specialize in more than one fields.
- Years of experience - single valued attribute.

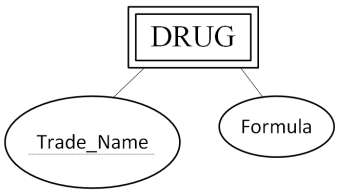
2.3) Draw a PHARMACY entity with attributes. Specify all attribute types.



The attributes of PHARMACY entity along with their corresponding types are as follows:

- Name - Single valued attribute which is also a key attribute.
- Phone_number - Multivalued attribute since a company can have many phone numbers associated with varies departments.
- Address - Composite attribute with four simple components; Street_Address, City, State and Zip.

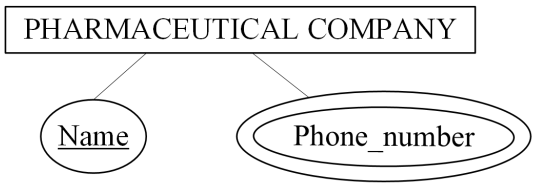
2.4) Draw a DRUG entity with attributes. Specify all attribute types.



The attributes of DRUG entity, which is a weak entity, along with their corresponding types are as follows:

- Trade_Name - Single valued attribute which is also a partial key attribute.
- Formula - Single valued attribute.

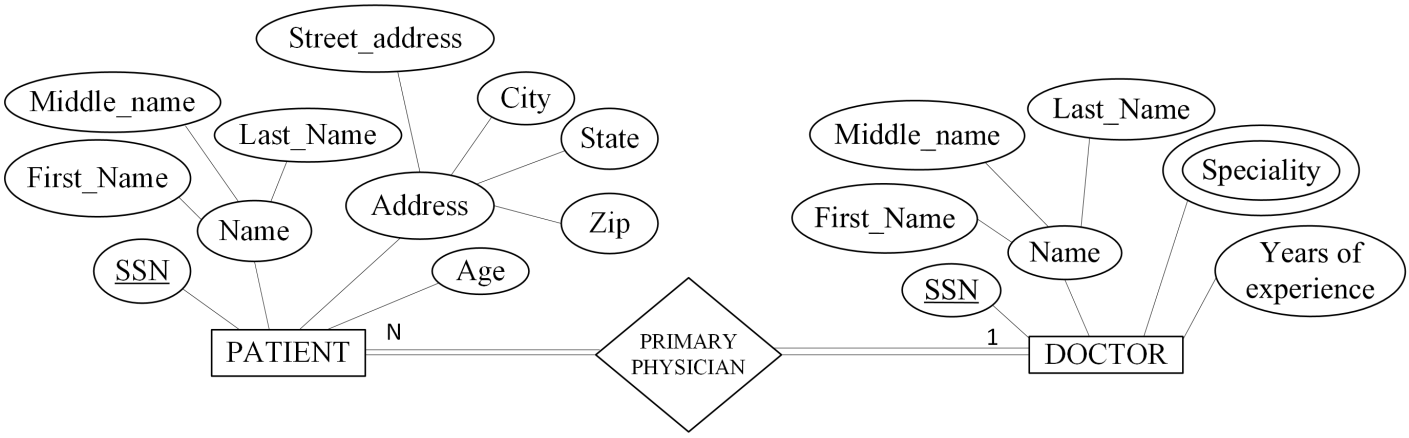
2.5) Draw a PHARM_COMPANY entity with attributes. Specify all attribute types.



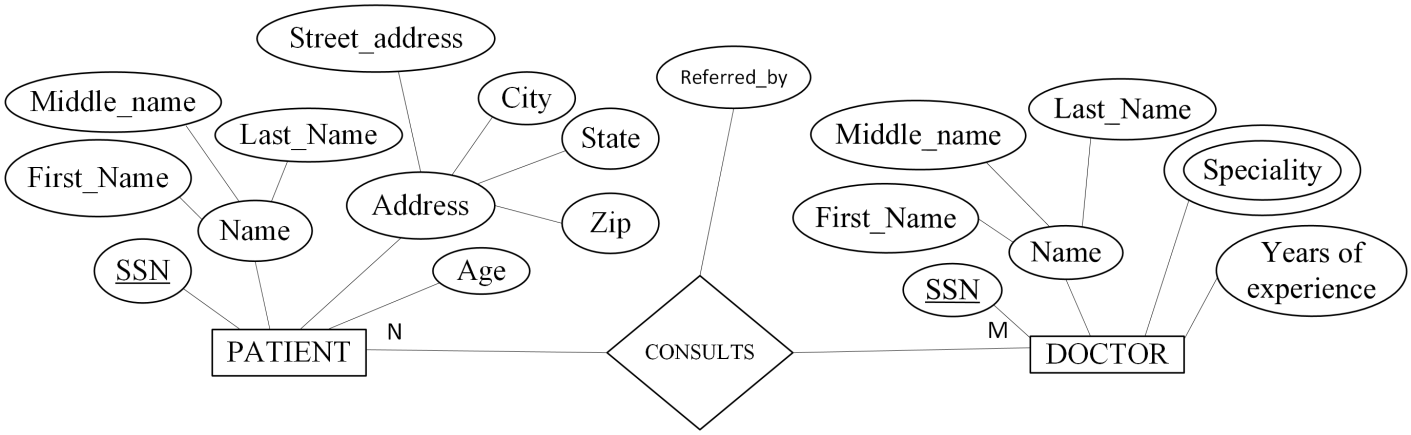
The attributes of PHARMACEUTICAL COMPANY entity along with their corresponding types are as follows:

- Name - Single valued attribute which is also a key attribute.
- Phone_number - Multivalued attribute since a company can have many phone numbers associated with varies departments.

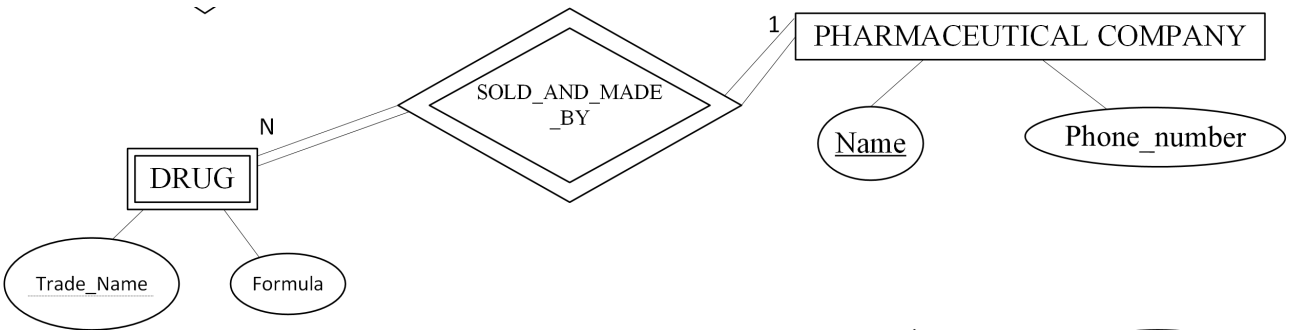
2.6) Draw the names of all relationship types and specify the constraint on each participation of an entity type in a relationship type.



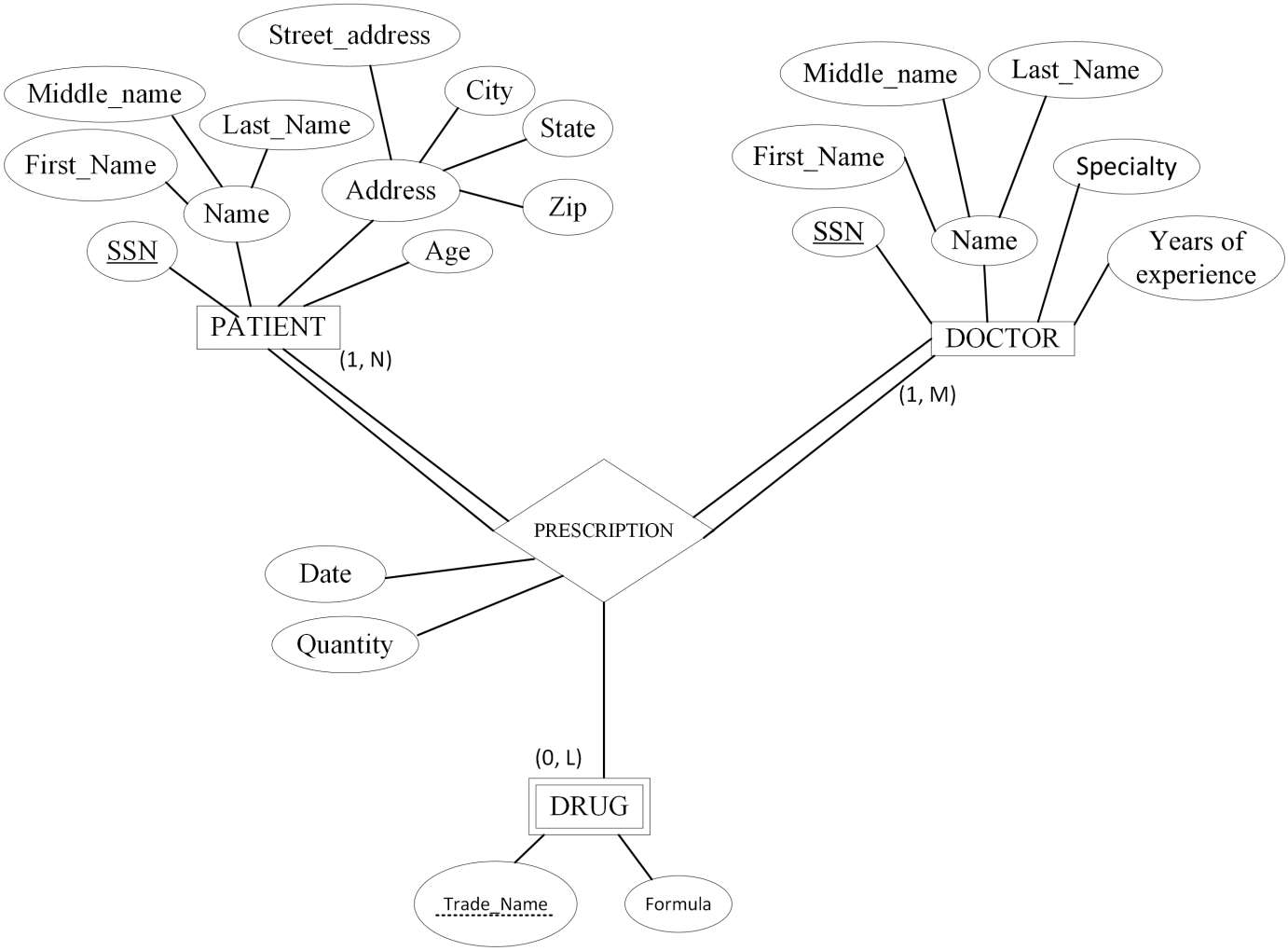
PRIMARY PHYSICIAN between PATIENT and DOCTOR. A patient has only one primary physician and a doctor can have many patients. Each doctor has atleast one patient as given in the problem statement.



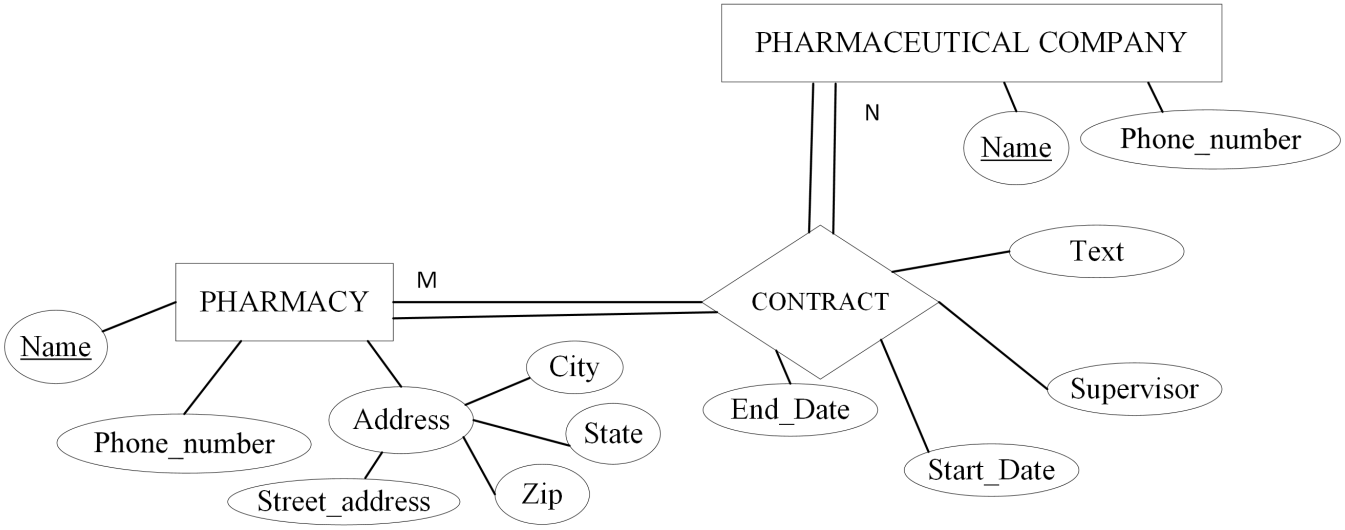
CONSULTS is a binary relationship between PATIENT and DOCTOR. A primary physician can forward the case to another doctor. Participation is not necessary here. This primary physician is recorded under the Referred_by attribute.



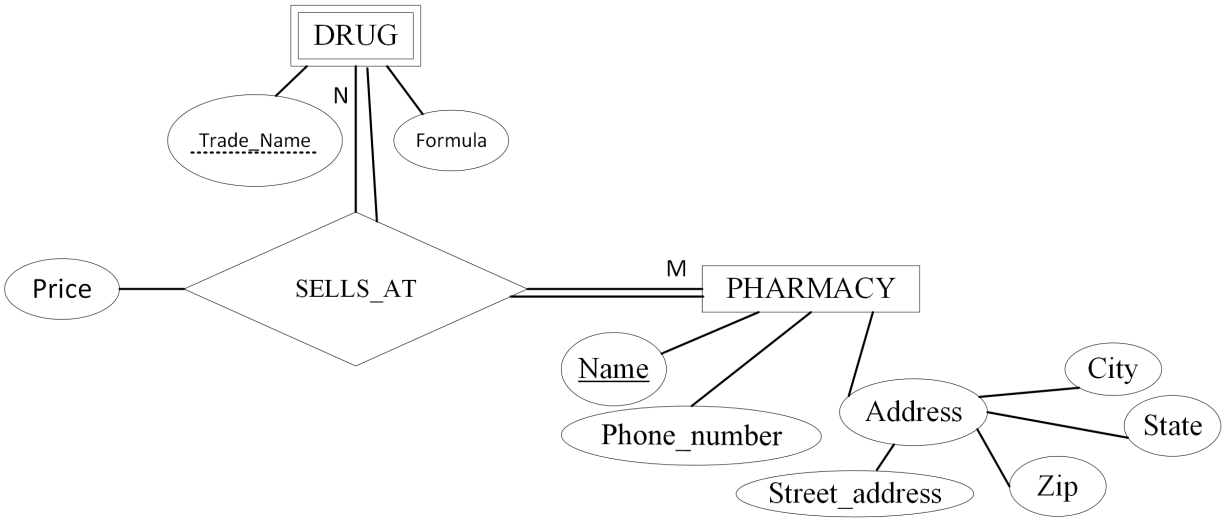
SOLD_AND_MADE_BY is a binary relationship between DRUG and PHARMACEUTICAL_COMPANY. Since, DRUG is a weak entity, there ought to be total participation from DRUG entity set in this relationship. For cardinality, a drug is made and sold by one pharmaceutical company and a company can sell many drugs.



PRESCRIPTION is a ternary relationship between PATIENT, DOCTOR and DRUG. Each patient should have a prescription after consulting a doctor and should be written by that doctor only. Additionally, data and quantity of drug should be specified on the prescription. It is not necessary that a doctor would prescribe a drug to a patient, he or she may simply write a note about some healthy habits. (1, N) indicates that a patient should have a minimum of 1 prescription and can have many more. Similarly, (1,M) indicates that a doctor has to prescribe atleast once and can have many more where (0,L) indicates that it is not necessary to that a prescription recommends a drug. L, M and N are not necessarily equal.



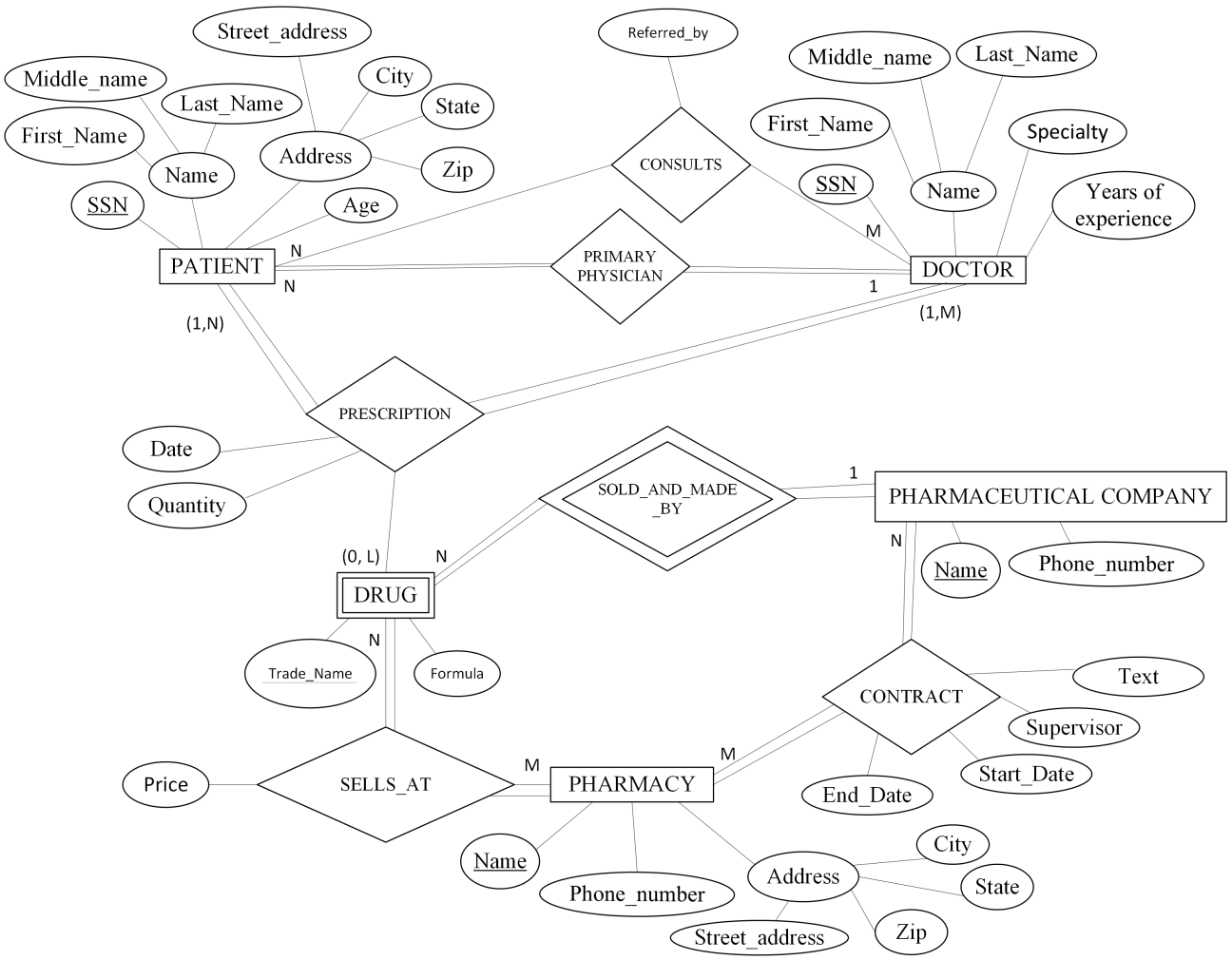
CONTRACT is a binary relationship between PHARMACY and PHARMACEUTICAL_COMPANY. There is a supervisor that overlooks the contract which also has a Start_Date, End_Date and Text that describes the contract. Considering that pharmacies sell drugs that are manufactured by pharm companies and these companies do not sell drugs directly to consumers, there's a total participation from both the entities in this relationship and there cardinality is N:M as pharmacies can have multiple number of contracts with various companies.



SELLS_AT is a binary relationship between DRUG and PHARMACY. Each drug can be found at a pharmacy and pharmcies sell multiple drugs, thereby indicating total participation and M:N cardinality.

2.7) Design and draw an ER diagram for that schema. Specify key attributes of each entity type and structural constraints on each relationship type. Note any unspecified requirements and make appropriate assumptions to make the specification complete. Identify any constraints that are not captured by the ER diagram.

- Here, we are considering that a doctor has only one specialty. If he or she specialises in more than one fields, it can be represented in the diagram using a double-oval for multi-valued attribute.
- Certain business rules cannot be depicted on ER diagrams but impose important constraints on the database. For example: as stated in the problem description, the supervisor of a contract changes from time to time. This cannot ve depicted here.
- Data type constraints cannot be captured in an ER diagram. Example: Age of a patient and years of experience of a doctor should be integers with a lower bound for doctors depends on the demographic.
- Length of data that is stored in a database cannot be captured in an ER diagram but it is necessary constraint when considering a three-tiered architecture of a dbms. The external view on our monitors can only display a limited number of characters of the text from the contract in an elegant manner.
- Sometimes patients can be prescribed a lot of drugs and some of these drugs may interact adversely with eachother. Although such a situation should be handled by doctors but it is still necessary to implement it and warn a patient if an error occurs.
- The functionality of storing the last prescription if a doctor prescribes the same drug cannot be handled with an ER diagram.
- ER DIAGRAM IS ON THE NEXT PAGE.


Street_address
Middle_name
Last_Name
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City
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Age
Referred_by
CONSULTS
Middle_name
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First_Name
Specialty
SSN
Name
Years of experience
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PATIENT
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PRIMARY PHYSICIAN
1
DOCTOR
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PRESCRIPTION
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SOLD_AND_MADE_BY
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Trade_Name
Formula
CONTRACT
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Supervisor
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End_Date
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