Question 1 Find the relational tables that correspond to the E-R diagram in Figure 1. Use as few tables as possible. For each relation, underline the primary key completely and list all foreign keys clearly on the side or by arrows.

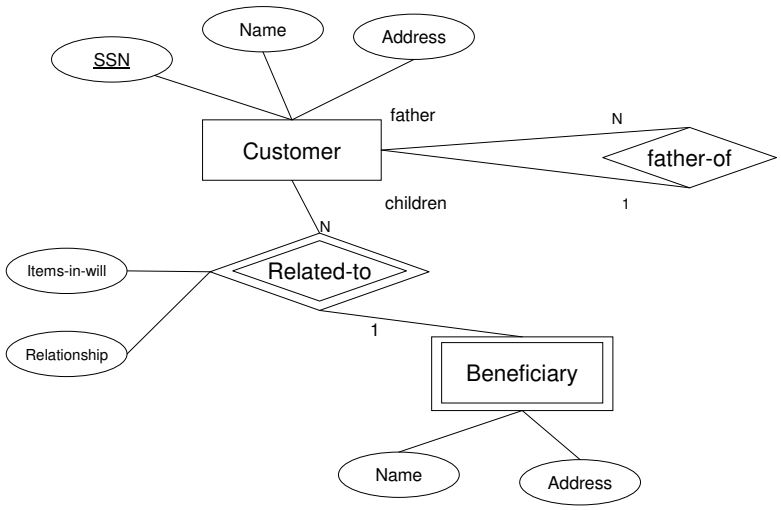

Figure 1: E-R diagram

Question 2 Map the E-R diagram in Figure 2 into a relational schema. Specify all primary keys and foreign keys.

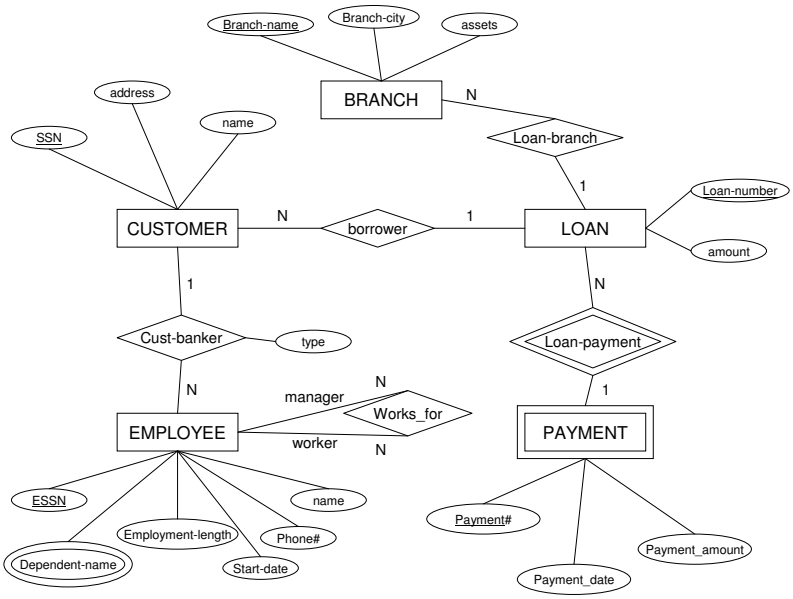

Figure 2: E-R diagram

Question 3 Find the equivalent relational schema for the diagram in Figure 3.

Question 4 You are given the E-R diagram in Figure 4. Convert this into an equivalent relational schema. Mark primary keys for each relation and the foreign keys if there are any.

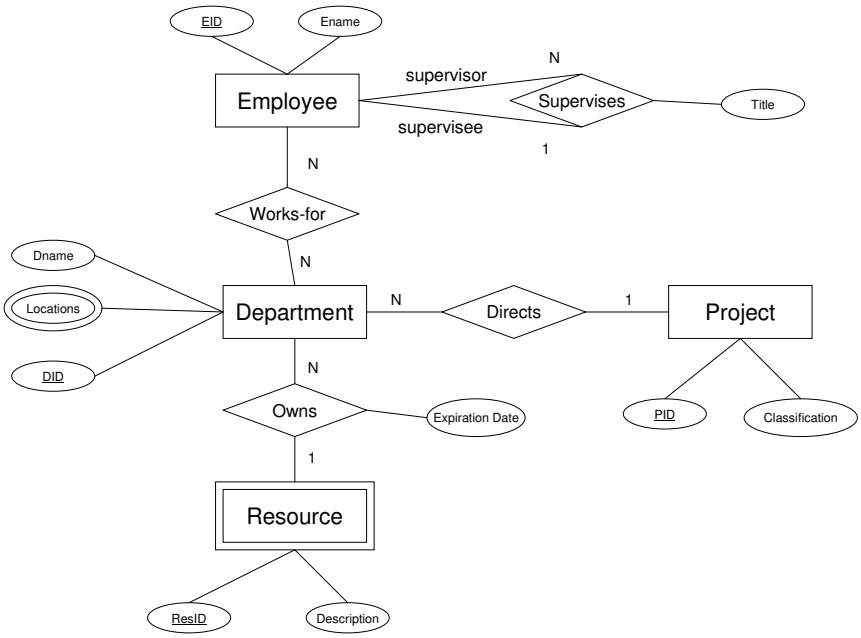

Figure 3: E-R diagram

Question 5 Suppose you are constructing a database for a radio station. Your database is going to store the CDs your station owns and also the program information about broadcasts of your station. You will store the following pieces of information:

- Assume you are given entities for songs, musicians, CDs and labels.
- For "broadcasters", you will store the name of radio personalities and other relevant information.
- For "shows", you will store the title, format, air date and time of different shows.
- Broadcasters usually have a number of shows they produce periodically.
- At each specific airing of a show, there is a play list which contains a number of songs from specific CDs in a particular order.

Draw an entity-relationship diagram for your database. You can use the E-R diagram from Question 1 as part of your database or introduce a modified version of it. Choose 2-4 attributes for each entity. Show all entities, relationships and attributes clearly. Clearly mark identifiers and the cardinalities of all relationships. If you make any assumptions about your database design, state them clearly.

Note: If you are using entities songs, musicians, CDs or labels in the solution, you do not have to show any attributes for these entities.

Question 6 You are asked to construct a database for managing the X-Files, i.e. criminal case descriptions and the people who were involved in these cases. A partial data model for the X-Files database is given below:

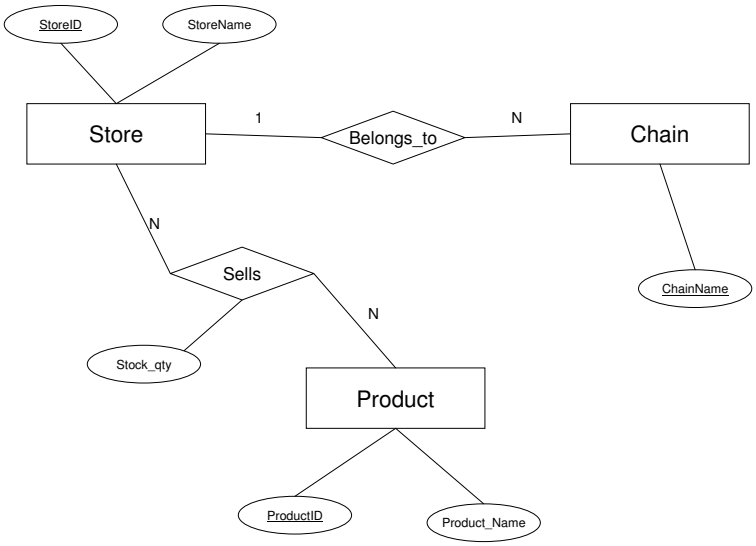

Figure 4: E-R diagram

Part 1. Convert the entity-relationship diagram in Figure 5 into a corresponding relational schema. List all tables. In each table, underline the primary identifier. If a specific attribute is a foreign key to another relation, write a short note indicating this. Use as few tables as possible.
Part 2. Add the following relationships to the entity relationship diagram in Part 1. Indicate the cardinalities clearly for all relationships.

A conspirator may be the father of one or more agents.

Each X-File may be the subject of one or more newspaper articles. Each article may refer to multiple X-File cases.

An X-File case may be related to another X-File case. The "follow-up" relationship indicates that an X-File may follow at most one earlier case, while a case may be followed by many new cases.

Question 7 This question has two parts:

Part 1.

You are given the E-R diagram in Figure 6. Add the following relationships to this diagram and mark the cardinalities of each relationship clearly.

HAVE-ACCOUNT: people have credit card accounts. Each credit card account has to have one or more people who owns that account. One person may have none, one or many credit accounts.

SPONSOR-ACCOUNT: stores sponsor credit card account. Each store may have none, one or more accounts. Each credit card may be sponsored by at most one store.

PUBLISH: stores publish catalogs. Each catalog has to belong to a store and each store may publish at most one catalog. A store may not publish a catalog at all.

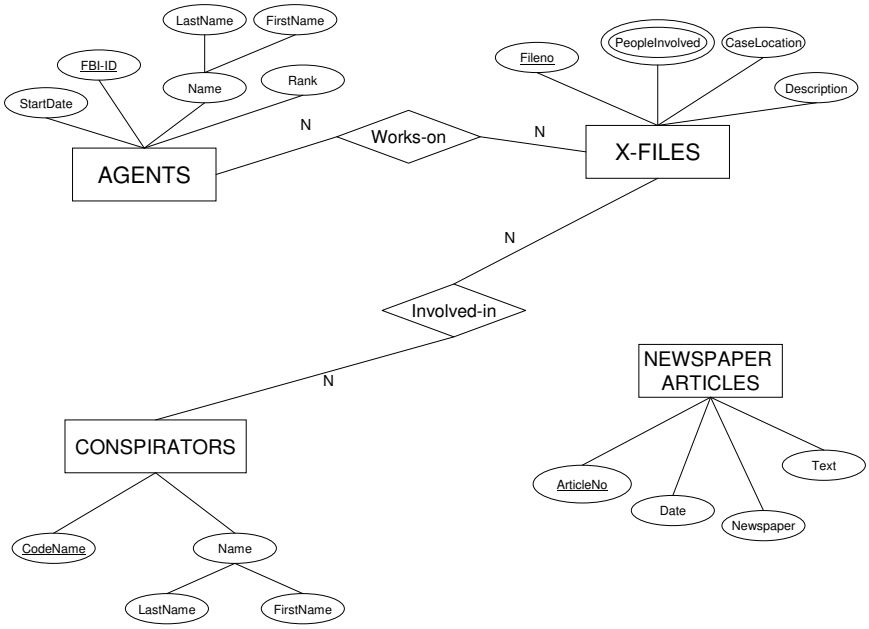

Figure 5: ER diagram

Part 2.

Convert the E-R diagram you constructed in Part 1 into the corresponding relational schema. List all tables. In each table, underline the primary identifier. If a specific attribute is a foreign key to another relation, write a short note indicating this. Use as few tables as possible.

Question 8 Map the Entity-Relationship diagram in Figure 7 into a relational database. Show the relations that would be in this database. For each relation, identify the primary key and any foreign keys.

Question 9 You are given a preliminary data model for a library. It consists of the following entities:

- BOOKS correspond to different books with a unique ISBN number.
- PUBLISHERS correspond to different publishing houses, with given name and address.
- AUTHORS correspond to different people who appear as authors with name, and birth date.
- COPIES correspond to individual copies of books. Each copy has a unique id.

Draw these entities as an entity relationship diagram. Do not add any attributes to the entities.

Add the following information as relationships with associated attributes and mark the cardinalities very carefully to enforce the following constraints whenever possible:

1. Authors write or edit books. Each book may have many authors and authors may write many books.
2. Publishers publish books, each book has a single publisher.

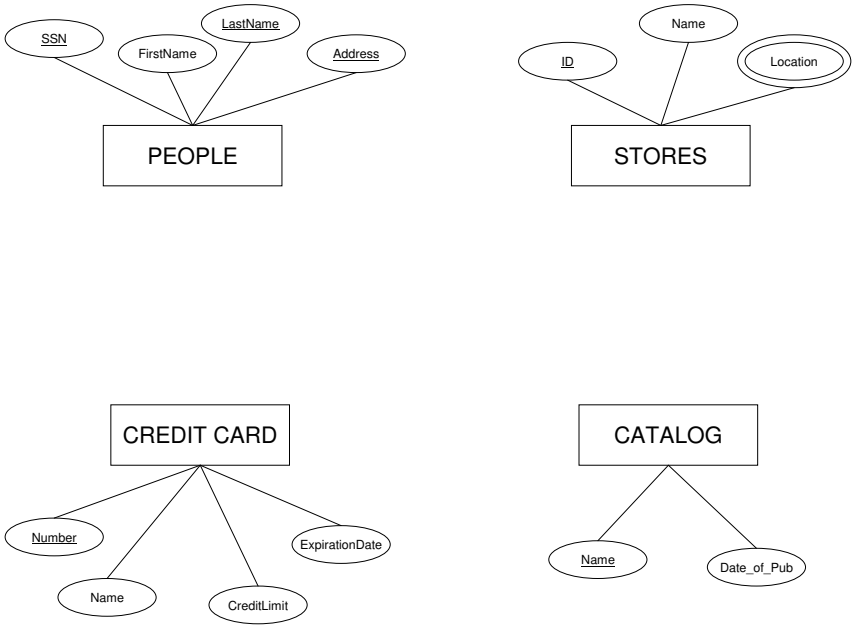

Figure 6: E-R diagram

3. Each copy is of a book. In fact, copy is a weak entity that depends on the book entity by a "copy-of" relationship.
4. Each author is affiliated with a publisher at a given year. At any year, each author is affiliated with a single publisher.
5. A book may be a new edition of an existing book. Each book can be the new edition of a single book.

Question 10 You are given the following simple database of employees that work in specific departments. Each department has an inventory of items with specific quantity.

EMPLOYEE(ssn, first-name, last-name, address, date-joined, supervisor-ssn)
DEPARTMENT(dept-no, name, manager-ssn)
WORKS-IN(employee-ssn, dept-no)
INVENTORY(dept-no, item-id, quantity)
ITEMS(item-id, item-name, type)

Foreign keys:

1. EMPLOYEE.supervisor-ssn and WORKS-IN.employee-ssn point to EMPLOYEE.ssn.
2. WORKS-IN.dept_no and INVENTORY.dept-no point to DEPARTMENT.dept_no.
3. INVENTORY.item-id points to ITEMS.item-id.

Assume in the above model that the key is unique for all relations. For example, two items with different id are considered different items. Furthermore, any attribute that is not part of a key can be null.

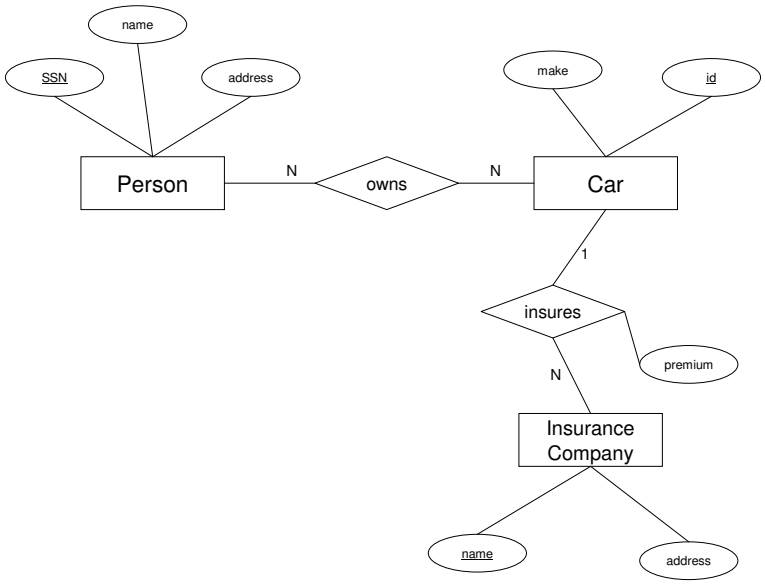

Figure 7: ER diagram

According to the data model above:

1. Can employees work in more than one department?
2. Can departments have more than one manager?
3. Can a different departments have the same item-id in their inventory?
4. Do employees have to work in the same department as their supervisor?

Explain your answers briefly by giving reasons from the relational data model.

Question 11 You are given the diagram in Figure 8 for storing information about a virtual store containing various items from different stores. Convert this entity relationship diagram to a relational database. For each relation, show the primary keys, list the foreign keys and write down which attribute they point to.

Question 12 In this question, you are asked to create an entity-relationship diagram for an auction house. In this database, people register as buyers and/or owners, post items, and place bids on items. First decide on the primary entities in your database and draw the major relationships between the entities. Then, add the necessary attributes for entities and relationships either on your graph or list them separately. If you make any assumptions, write them down explicitly. Show the participation cardinalities of all relationships, and mark primary keys.
Your database should capture the following information.

ITEMS:

- Each item has a name, description, pictures, a minimum price, an increment, and an expiry date associated with it.

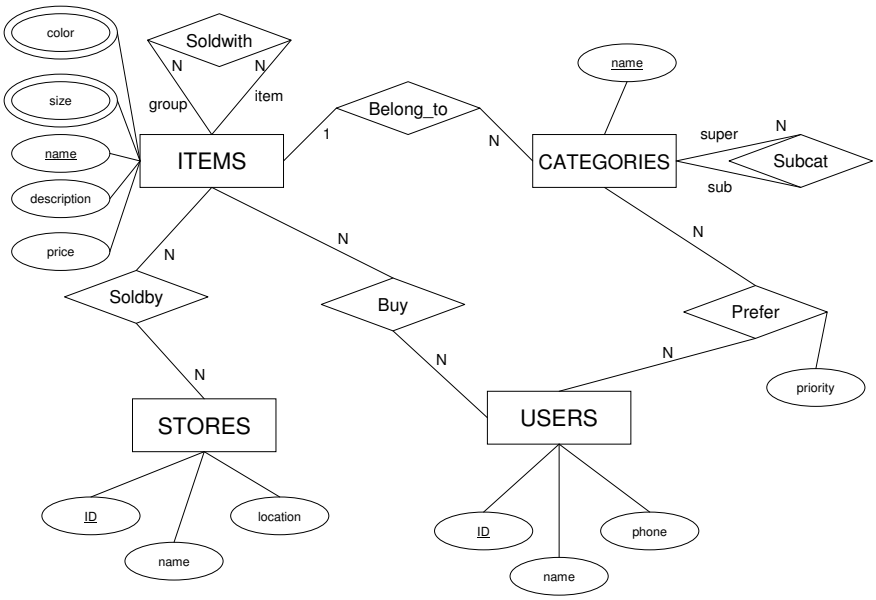

Figure 8: E-R diagram

- For each item, the current maximum bid is also stored explicitly.
- Items are owned by a specific owner.

OWNERS:

- Owners have information such as name, phone number, address, preferred payment method.
- In addition, owners have ratings which are determined by the comments made about them.
- Only owners can introduce new items to be sold at the store and also accept a specific bid.

BUYERS:

- Buyers have similar information as owners. However, only buyers can place bids on items.
- A person can be an owner, a buyer or both.

ACTIVE_BIDS:

- Each bid is made at a specific time, for a specific item and for a specific amount.
- Each bid is made by a single buyer.

TRANSACTIONS:

- Each transaction involves a buyer, an owner, a date and an amount. This means that an owner accepted a bid by a buyer for the given amount.

COMMENTS:

- Both owners and buyers can comment on the transaction they have conducted. Owners can rate buyers and vice versa.
- For each comment, there is commentor (person commenting), commentee (the person being commented on), a rating (one of five set values poor to excellent), and additional notes.

In addition, owners can accept any bid for an item they are selling. At this time, both the item and all the bids for the item are removed from the database (this has to supported as application logic separately) and a transaction tuple is generated.

Question 13 Draw an entity-relationship diagram for the following database. Draw entities and relationships carefully. For each relationship, write the min and max participation cardinalities for all entities it combines. For each entity, draw at least 4 representative attributes and mark the primary key carefully.

Since everything about this model is not specified in detail, you need to decide what is "reasonable" for this application. If you make any assumptions about your model, write them down as short notes.

In this database, you will represent the following information about a university:

- The university has a number of schools and different departments in each school. It also has a number of faculty and centers for research.
- Faculty members have names, ssn, major interests, office location and number.
- school has a Dean, which is a faculty member.
- A department has a chair, which is a faculty member.
- Each faculty is in a single department, but they may have joint appointments with multiple departments and research centers.
- Research centers have directors, which are also faculty members.
- Faculty and research centers receive grants. Each grant has a starting date, amount, granting institution and a program director. There may be multiple faculty and/or research centers affiliated with a grant.

DESIGN NOTES:

When designing a database, you should try to keep in mind the following conflicting rules:

- A simple database is easier to implement. This usually means you should try to limit the number of entities and relationships as much as possible –as long as you can capture everything that you need in the data model.
- Each entity should have a specific logical meaning/purpose. While you would be simplifying the data model by combining many similar entities to a single entity, you will need to handle exceptions in application code later on.

You should try to find the appropriate balance between these two factors in your design.

Question 14 You are given an entity-relationship diagram shown in Figure 9 and 10. Convert this to an equivalent and succinct relational schema (i.e. set of relations). Underline the primary key of each relation. List all foreign keys.

Example. R(A, B), S(D,E, F), Foreign keys: S.F references R.A.

Question 15 You are given the below relational model.

Artist(ArtistName, ArtistYear, Origin, ArtistTones, Biography)
Song(SongId, SongName, DateComposed)
Album(AlbumId, AlbumTitle, Duration, Rating, Review, ReleaseDate, AlbumTones,
ArtistName, ArtistYear, LabelName)

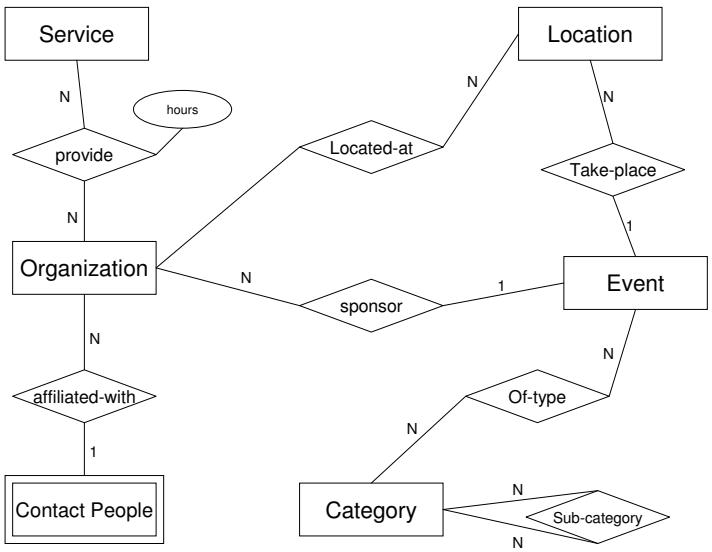

Figure 9: Relationships

Track(AlbumId, TrackId, Recommended, SongId)
LyricsBy(SongId, ArtistName, ArtistYear)
MusicBy(SongId, ArtistName, ArtistYear)
MajorArtist(ArtistName ArtistYear, LabelName)

Foreign keys:

Album(ArtistName, ArtistYear) → Artist(ArtistName, ArtistYear)
Track(AlbumId) → Album(AlbumId)
Track(SongId) → Song(SongId)
LyricsBy(SongId) → Song(SongId)
MusicBy(SongId) → Song(SongId)
LyricsBy(ArtistName, ArtistYear) → Artist(ArtistName, ArtistYear)
MusicBy(ArtistName, ArtistYear) → Artist(ArtistName, ArtistYear)
MajorArtist(ArtistName, ArtistYear) → Artist(ArtistName, ArtistYear)

According to the above data model, answer the following questions. Answer yes or no, and give a short (one sentence) explanation.

1. Is it possible for the same artist to write both the lyrics and music of the same song?
2. Is it possible for more than one artist to write the lyrics of the same song?
3. Is it possible for two artists to have same name?
4. Is it possible for two albums to have the same name?

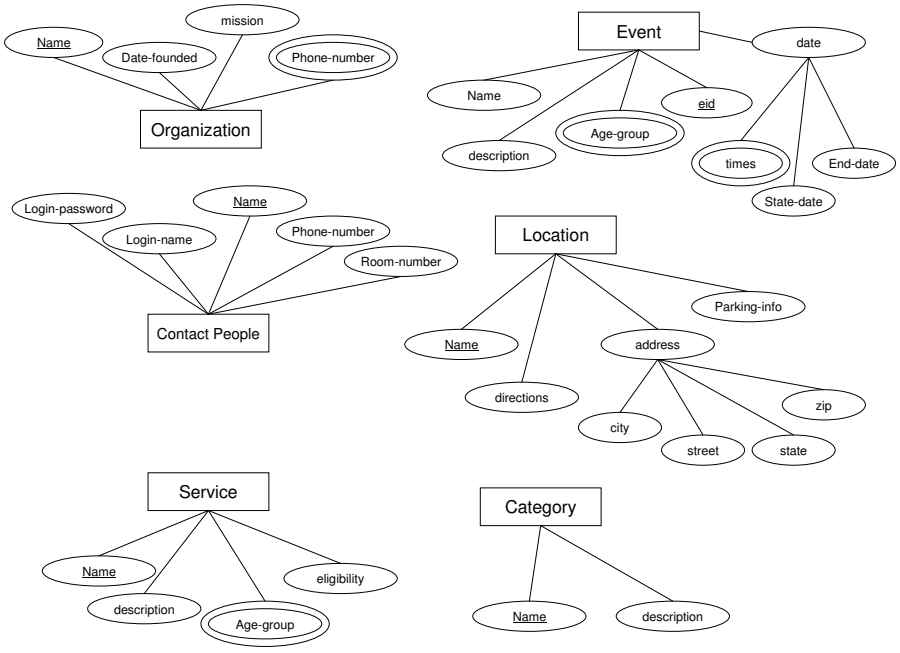

Figure 10: Attributes for the entities

5. Is it possible for an album to have no tracks?

Question 16 You are given the following entities. Draw an Entity-Relationship diagram and place these entities. Add to this diagram the relationships below. For each relationship, clearly mark the participation constraints on all sides and draw the associated attributes if there are any.
Entities:

- Book [primary key: ISBN]
- Publisher [primary key: name]
- Company [primary key: name]
- BookStore [primary key: name, address]

Relationships:

- Each company is affiliated with specific publishers. Companies should have at least three affiliated publishers and can have as many as possible. Each publisher can be affiliated with zero or more companies.
- Each book is published by one and only one publisher. Each publisher can publish many books.
- A book may be a new edition of an existing book, but it does not have to be. Each book may or may not have new editions. Each edition has a number.
- Each bookstore may belong to a specific company. A bookstore may be independent, and it may not belong to any company in the database. A company may have many bookstores.

- Each bookstore carries books. A book can be carried by none or many bookstores and each bookstore can carry none or many books.

Question 17 You are given the entity relationship diagram shown in Figure 11:

1. Find the corresponding relational data model. Indicate foreign keys clearly.
2. Answer the following questions true or false with a short explanation:
   (a) Should each review be written by a news reviewer?
   (b) Should each movie have a remake?
   (c) Should each newsreviewer work for a specific newspaper?

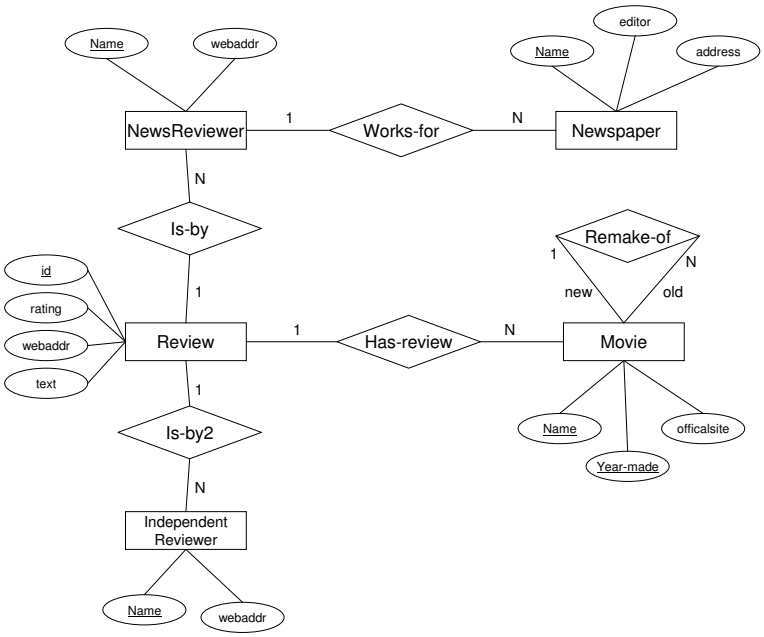

Figure 11: E-R diagram

Question 18 Draw an Entity-Relationship diagram for the following database. Books have a title, ISBN number, and a price. Authors have a name and address. Publishing companies have a name and address. One or more authors write a book. Authors often write more than one book. One publishing company publishes each book. A publishing company can publish many books. Each author of a book is paid a fee for writing the book. When multiple authors write a book they do not necessarily all receive the same fee. The fees also vary between books.

Question 19 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 position(s) they played in the game, and the result of the game. Design an Entity Relationship Diagram for this database. State any assumptions you make. Choose your favorite sport (hockey, football, baseball, basketball, etc.).