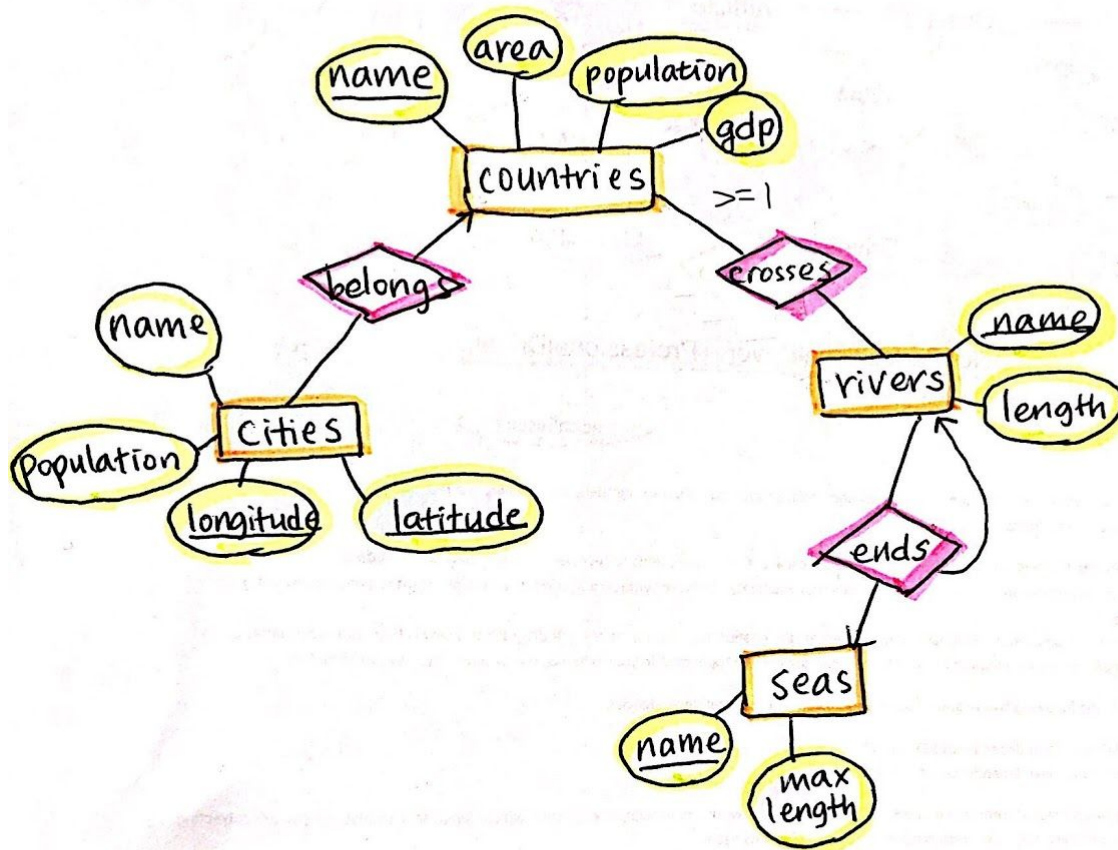


1.



2.

```
CREATE TABLE InsuranceCo(  
    name VARCHAR(50) PRIMARY KEY,  
    phone INT  
);
```

```
CREATE TABLE Person(  
    ssn INT PRIMARY KEY,  
    name VARCHAR(50)  
);
```

```
CREATE TABLE Driver(  
    ssn INT PRIMARY KEY,  
    driverID INT,  
    FOREIGN KEY (ssn) REFERENCES Person(ssn)
```

);

```
CREATE TABLE Vehicle(  
    licensePlate VARCHAR(50) PRIMARY KEY,  
    year INT,  
    maxLiability REAL,  
    name VARCHAR(50),  
    ssn INT,  
    FOREIGN KEY (name) REFERENCES InsuraceCo(name),  
    FOREIGN KEY (ssn) REFERENCES Person(ssn)  
);
```

```
CREATE TABLE Car(  
    licensePlate VARCHAR(50) PRIMARY KEY,  
    make VARCHAR(50),  
    FOREIGN KEY (licensePlate) REFERENCES Vechicle(licensePlate)  
);
```

```
CREATE TABLE NonProfessionalDriver(  
    driverID INT PRIMARY KEY,  
    FOREIGN KEY (driverID) REFERENCES Driver(driverID)  
);
```

```
CREATE TABLE ProfessionalDriver(  
    driverID INT PRIMARY KEY,  
    medicalHistory VARCHAR(50),  
    FOREIGN KEY (driverID) REFERENCES Driver(driverID)  
);
```

```
CREATE TABLE Truck(  
    licensePlate VARCHAR(50) PRIMARY KEY,  
    capacity INT,  
    ssn INT,  
    FOREIGN KEY (licensePlate) REFERENCES Vehicle(licensePlate),  
    FOREIGN KEY (ssn) REFERENCES Driver(ssn)  
);
```

```
CREATE TABLE Drives(  
    licensePlate VARCHAR(50),  
    driverID INT,  
    PRIMARY KEY(licensePlate, driverID),  
    FOREIGN KEY (licensePlate) REFERENCES Car(licensePlate),  
    FOREIGN KEY (driverID) REFERENCES NonProfessionalDriver(driverID),
```

);

Which relation in your relational schema represents the relationship “insures” in the E/R diagram and why is that your representation?

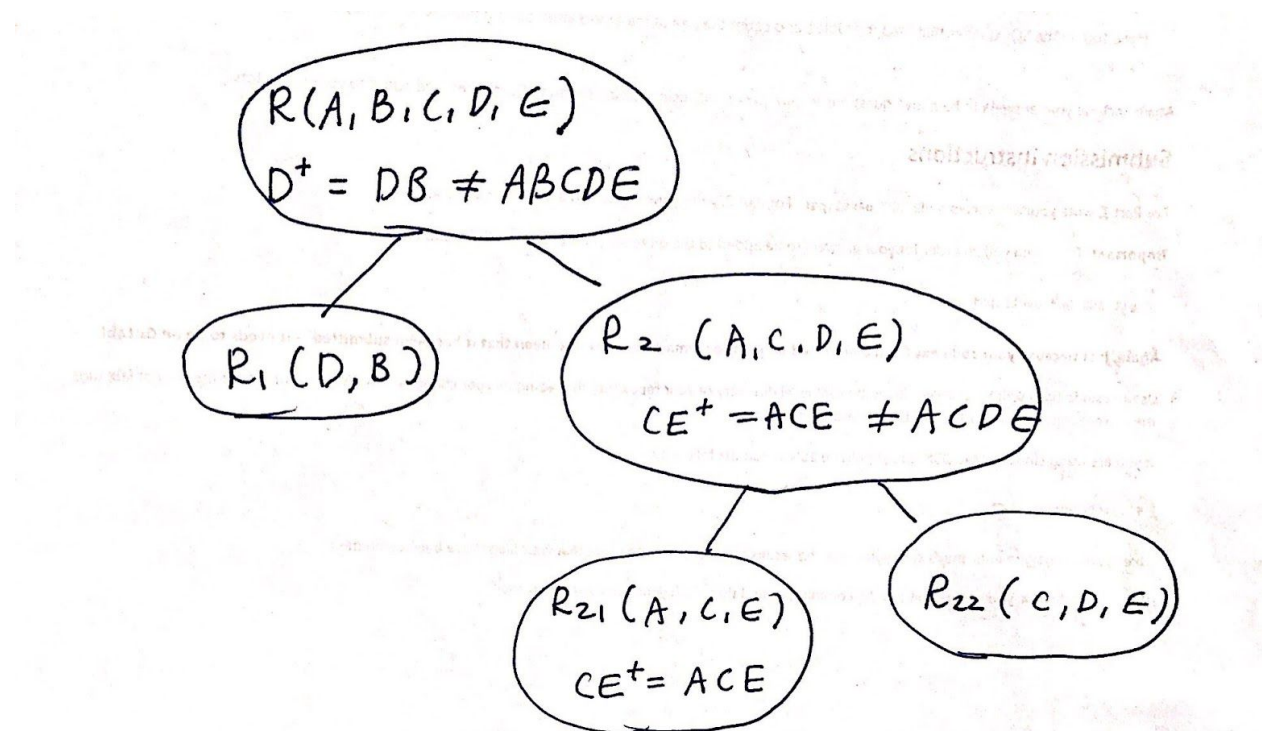
Vehicle(licensePlate, year, InsuranceCo.name, maxLiability, Person.ssn)

Since a vehicle is insured by InsuranceCo, and it's many - one relationship. Also, name which is InsuranceCo's primary key is one of attributes of Vehicle.

Compare the representation of the relationships “drives” and “operates” in your schema, and explain why they are different.

“Drives” is many-many relationship, so it needs additional relationship, while “operates” is many-one relationship, so a truck can refer a single ProfessionalDriver.

3.



From $R(A, B, C, D, E)$, $D^+ = (D, B)$ which doesn't satisfy BCNF requirements because it's neither (D) nor (A, B, C, D, E) . So, $R(A, B, C, D, E)$ is decomposed into $R_1(D, B)$ and $R_2(A, C, D, E)$.

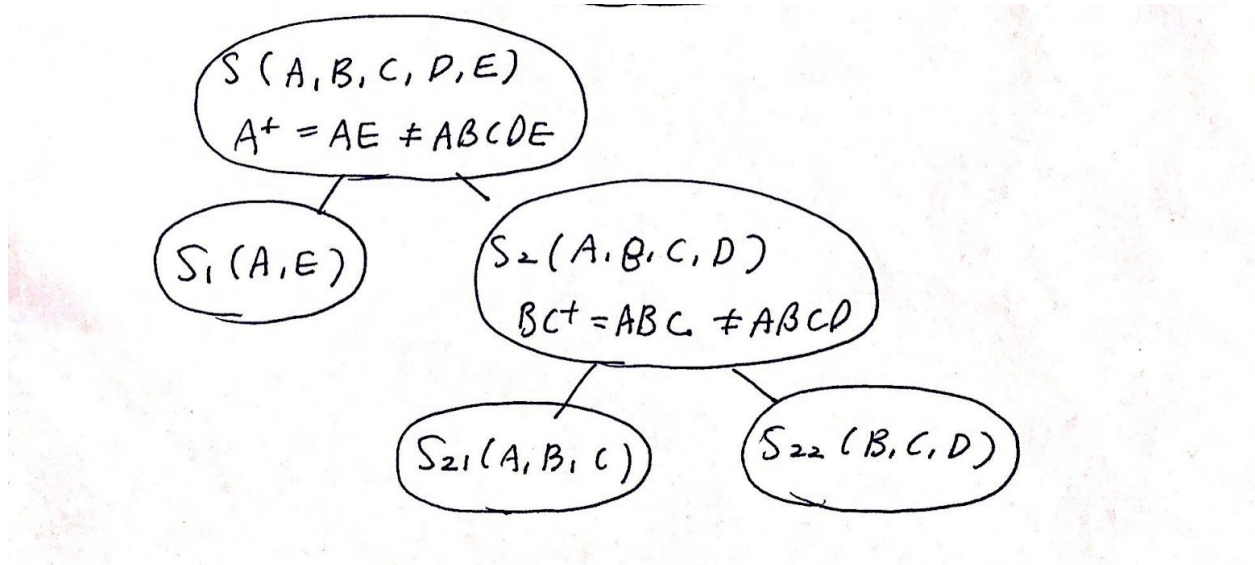
For $R_1(B, D)$, $B^+ = (B)$ and $D^+ = (B, D)$, so both satisfy BCNF requirements. $R_1(B, D)$ is a key.

For $R_2(A, C, D, E)$, $CE^+ = (A, C, E)$ and it's not (A, C, D, E) , so $R_2(A, C, D, E)$ is decomposed into $R_{21}(A, C, E)$ and $R_{22}(C, D, E)$.

For $R_{21}(A, C, E)$, $A^+ = (A)$, $C^+ = (C)$, $E^+ = (E)$, and $CE^+ = (A, C, E)$, so it meets BCNF requirements.

For $R_{22}(C,D,E)$, $C \rightarrow D$, $D \rightarrow E$, and $E \rightarrow C$. This also meets BCNF requirements.

→ $R_1(B,D)$, $R_{21}(A,C,E)$, $R_{22}(C,D,E)$



From $S(A,B,C,D,E)$, $A \rightarrow E$ which is not (A,B,C,D,E) , so it's decomposed into $S_1(A,E)$ and $S_2(A,B,C,D)$.

For $S_1(A,E)$, $A \rightarrow A$ and $E \rightarrow E$, so it satisfies BCNF requirements.

For $S_2(A,B,C,D)$, $BC \rightarrow A$ which is not (A,B,C,D) , so it is also decomposed into $S_{21}(A,B,C)$ and $S_{22}(B,C,D)$.

For $S_{21}(A,B,C)$, $A \rightarrow B$, $B \rightarrow C$, and $BC \rightarrow A$, so it's a key.

For $S_{22}(B,C,D)$, $B \rightarrow C$, $C \rightarrow D$, and $D \rightarrow B$ which also meet BCNF requirements.

→ $S_1(A,E)$, $S_{21}(A,B,C)$, $S_{22}(B,C,D)$

4.

All sets of attributes are closed.

$A \rightarrow B$, $B \rightarrow C$, $C \rightarrow D$, $D \rightarrow A$

The only closed sets are \emptyset and $\{A,B,C,D\}$.

$A \rightarrow B$, $B \rightarrow C$, $C \rightarrow D$, $D \rightarrow A$

The only closed sets are \emptyset , $\{A,B\}$, and $\{A,B,C,D\}$.

$A \rightarrow B$, $B \rightarrow A$, $C \rightarrow A,B,D$, $D \rightarrow A, B, C$