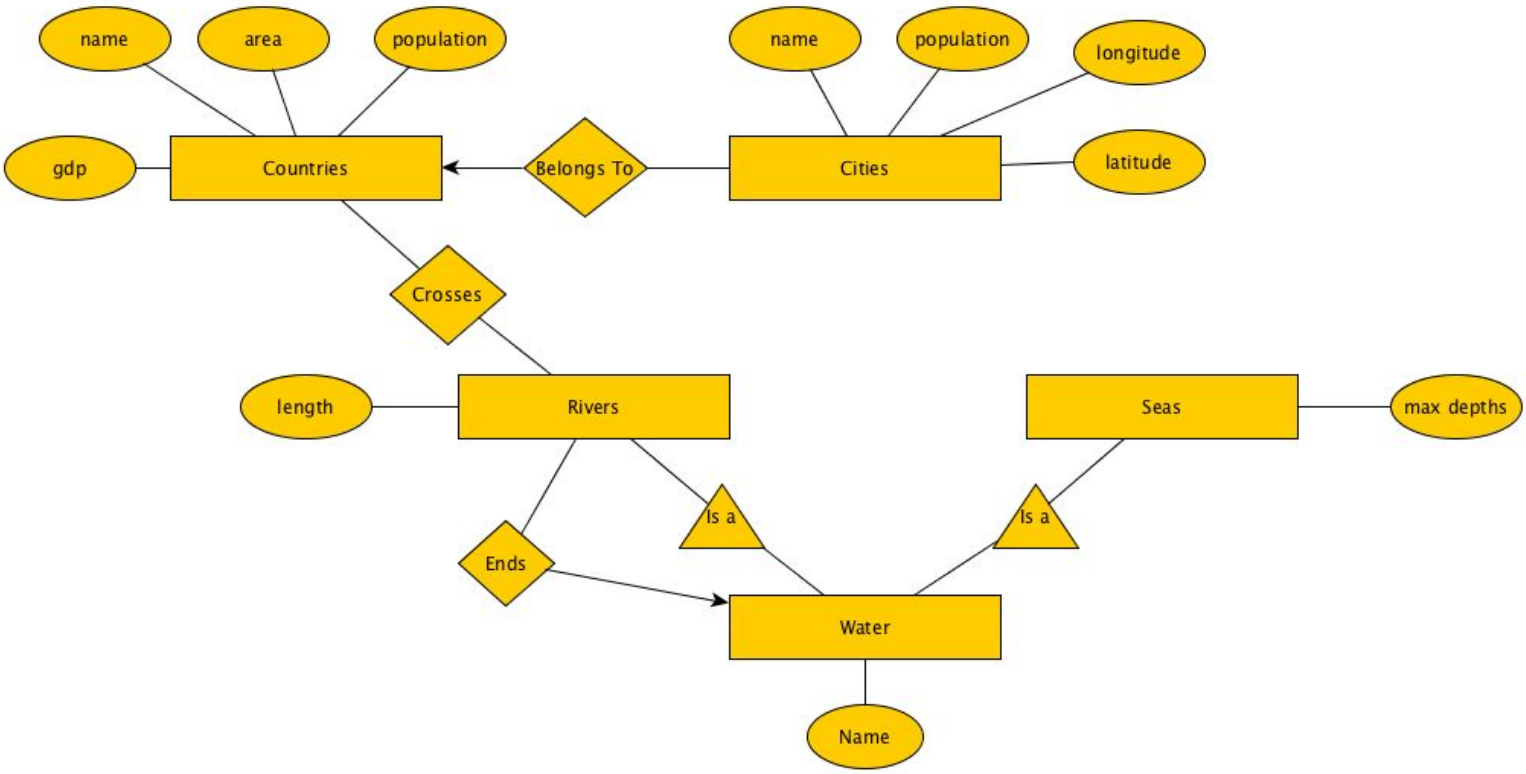
1.)



2a.)

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

CREATE TABLE Vehicle(
        licensePlate VARCHAR(100) PRIMARY KEY,
        year INT,
        maxLiability INT,
        maxLossDamage INT,
        name VARCHAR(30) REFERENCES InsuranceCo
        SSN VARCHAR(15) REFERENCES Person
);
```

```
CREATE TABLE Person(
        name VARCHAR(50),
        SSN VARCHAR(15) PRIMARY KEY
);

CREATE TABLE Driver(
        licenseNo VARCHAR(20) PRIMARY KEY
        SSN VARCHAR(15) REFERENCES Person
);

CREATE TABLE Car(
        make VARCHAR(20)
        licensePlate VARCHAR(100) PRIMARY KEY,
        FOREIGN KEY(licensePlate) REFERENCES Vehicle
);

CREATE TABLE Truck(
        capacity INT,
        licensePlate VARCHAR(100) PRIMARY KEY,
        licenseNo VARCHAR(20) REFERENCES ProfessionalDriver
        FOREIGN KEY(licensePlate) REFERENCES Vehicle
);

CREATE TABLE NonProfessionalDriver(
        licenseNo VARCHAR(20) PRIMARY KEY
        FOREIGN KEY(licenseNo) REFERENCES Driver
);

CREATE TABLE ProfessionalDriver(
        medicalHistory VARCHAR(100),
        licenseNo VARCHAR(20) PRIMARY KEY
        FOREIGN KEY(licenseNo) REFERENCES Driver
);

CREATE TABLE drives(
        licenseNo VARCHAR(20) REFERENCES NonProfessionalDriver,
        licensePlate VARCHAR(100) REFERENCES Car,
        PRIMARY KEY(licenseNo, licensePlate)
);
```

2b.) I represented the relationship “insures” by putting it’s attributes inside Vehicle. This is because “insures” is a many to one relationship where there can only be one InsuranceCo

insuring one or many vehicles. Thus, all the attribute information can be kept in the Vehicle schema and do not require a separate table just for this relationship.

2c.) I represented the relationship “drives” through another table while “operates” had it’s attributes put inside ProfessionalDriver’s schema. This is because “drives” is a many to many relationship thus no single schema can hold all of the attributes required. However, “operates” is a many to one relationship where only one ProfessionalDriver can own one or many Trucks. Thus, the attributes can be kept in ProfessionalDriver’s schema.

3i.) R(A,B,C,D,E)
with FD: {D -> B, CE -> A}

1. Decomposing: {A,B,C,D,E}
   FD => D^+={D,B}
   a. Dependency Violations: D^+ != {D} or {A,B,C,D,E}
   b. Decomposes to {D,B} and {A,C,D,E}
2. Decomposing: {A,C,D,E}
   FD => CE^+={C,E,A}
   a. Dependency Violations: CE^+ !={C,E} or {A,C,D,E}
   b. Decomposes to {C,E,A} and {C,D,E}
3. BCNF = {D,B}, {C,E,A}, {C,D,E}

3ii.) S{A,B,C,D,E}
with FD: {A -> E, BC -> A, DE -> B}

1. Decomposing: {A,B,C,D,E}
   FD => A^+={A,E}
   a. Dependency Violations: A^+ != {A} or {A,B,C,D,E}
   b. Decomposes to {A,E} and {A,B,C,D}
2. Decomposing: {A,B,C,D}
   FD => BC^+={B,C,A}
   a. Dependency Violations: BC^+ != {B,C} or {A,B,C,D}
   b. Decomposes to {B,C,A} and {B,C,D}
3. BCNF = {A,E}, {B,C,A}, {B,C,D}

4.) R(A,B,C,D)

A. FD: {A -> A; B -> B; C -> C; D -> D}
B. FD: {A -> B; B -> C; C -> D; D -> A}
C. FD: {A -> B; B -> A; C -> D,A,B; D -> C,A,B}

5ii.)

```
-- name -> price
SELECT COUNT(*)
FROM Sales s, Sales s2
```

```
WHERE s.name = s2.name
AND s.price != s2.price;
-- Result: 0, this is a FD

-- month -> discount
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.month = s2.month
AND s.discount != s2.discount;
-- Result: 0, this is a FD

-- name -> discount, price
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.name = s2.name
AND s.discount != s2.discount
AND s.price != s2.price;
-- Result: 0, this is a FD

-- name -> month, price
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.name = s2.name
AND s.month != s2.month
AND s.price != s2.price;
-- Result: 0, this is a FD

-- month -> name, discount
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.month = s2.month
AND s.name != s2.name
AND s.discount != s2.discount;
-- Result: 0, this is a FD

-- month -> discount, price
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.month = s2.month
AND s.discount != s2.discount
AND s.price != s2.price;
-- Result: 0, this is a FD
```

```
-- name -> discount, month, price
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.name = s2.name
AND s.discount != s2.discount
AND s.month != s2.month
AND s.price != s2.price;
-- Result: 0, this is a FD

-- month -> name, discount, price
SELECT COUNT(*)
FROM Sales s, Sales s2
WHERE s.month = s2.month
AND s.name != s2.name
AND s.discount != s2.discount
AND s.price != s2.price;
-- Result: 0, this is a FD
```

5iii.) R(name, discount, month, price)

with FD: {name -> price, month -> discount}

1. Decomposing: {name, discount, month, price}
   FD => $name^+$ = {name, price}
   a. Dependency Violations: $name^+$!= {name} or {name, discount, month, price}
   b. Decomposes to {name, discount, month} and {name, price}
2. Decomposing: {name, discount, month}
   FD => $month^+$={month, discount}
   a. Dependency Violations: $month^+$!={month} or {name, discount, month}
   b. Decomposes to {name, month} and {month, discount}
3. BCNF = {name, price}, {name, month}, {month, discount}

```
CREATE TABLE Sales1(
        name VARCHAR(20) PRIMARY KEY,
        price INT
);

CREATE TABLE Sales2(
        month VARCHAR(5) PRIMARY KEY,
        discount VARCHAR(10)
);

CREATE TABLE Sales3(
        name VARCHAR(20) REFERENCES Sales1,
        month VARCHAR(5) REFERENCES Sales2
```

);

5iv.)

```
-- Sales1
INSERT INTO Sales1
SELECT DISTINCT name, price
FROM Sales;

/*
name        price
----------  ----------
bar1        19
bar8        19
gizmo3      19
gizmo7      19
mouse1      19
gizmo6      29
gizmo4      29
mouse3      29
mouse7      29
bar4        29
bar7        29
click7      29
bar9        39
click1      39
click2      39
click3      39
click8      39
click4      49
click9      49
gizmo1      49
mouse2      49
mouse8      59
bar2        59
bar3        59
mouse9      69
mouse4      69
gizmo9      79
gizmo5      79
gizmo8      89
mouse5      89
click6      89
```

```
bar5        89
bar6        99
mouse6      99
click5      99
gizmo2      99
*/

-- Sales2

INSERT INTO Sales2
SELECT DISTINCT month, discount
FROM Sales;

/*
month       discount
----------  ----------
apr         15%
aug         15%
dec         33%
feb         10%
jan         33%
jul         33%
jun         10%
mar         15%
may         10%
nov         15%
oct         10%
sep         15%
*/

-- Sales3

INSERT INTO Sales3
SELECT DISTINCT name, month
FROM Sales;

/*
name        month
----------  ----------
bar1        apr
bar8        apr
gizmo3      apr
gizmo7      apr
```

mouse1 apr
bar1 aug
bar8 aug
gizmo3 aug
gizmo7 aug
mouse1 aug
bar1 dec
bar8 dec
gizmo3 dec
gizmo7 dec
mouse1 dec
bar1 feb
bar8 feb
gizmo3 feb
gizmo7 feb
mouse1 feb
bar1 jan
bar8 jan
gizmo3 jan
gizmo7 jan
bar1 jul
bar8 jul
gizmo3 jul
gizmo7 jul
mouse1 jul
bar1 jun
bar8 jun
gizmo3 jun
gizmo7 jun
mouse1 jun
bar1 mar
bar8 mar
gizmo3 mar
gizmo7 mar
mouse1 mar
bar1 may
bar8 may
gizmo3 may
gizmo7 may
mouse1 may
bar1 nov
bar8 nov
gizmo3 nov

gizmo7 nov
mouse1 nov
bar1 oct
bar8 oct
gizmo3 oct
gizmo7 oct
mouse1 oct
bar1 sep
bar8 sep
gizmo3 sep
gizmo7 sep
mouse1 sep
gizmo6 sep
gizmo4 sep
mouse3 sep
mouse7 sep
mouse7 oct
bar4 sep
bar7 sep
click7 sep
gizmo6 oct
mouse3 oct
gizmo4 oct
click7 oct
bar4 oct
bar7 oct
mouse7 nov
mouse3 nov
gizmo6 nov
gizmo4 nov
bar4 nov
bar7 nov
click7 nov
mouse7 may
gizmo6 may
mouse3 may
gizmo4 may
click7 may
bar4 may
bar7 may
mouse7 mar
mouse3 mar
gizmo6 mar

gizmo4 mar
mouse7 jun
bar4 mar
bar7 mar
click7 mar
gizmo6 jun
mouse3 jun
gizmo4 jun
click7 jun
bar4 jun
bar7 jun
mouse7 jul
mouse3 jul
gizmo6 jul
gizmo4 jul
bar4 jul
bar7 jul
click7 jul
mouse7 jan
mouse3 jan
gizmo4 jan
gizmo6 jan
click7 jan
bar4 jan
bar7 jan
mouse7 feb
mouse3 feb
gizmo4 feb
gizmo6 feb
click7 feb
mouse7 dec
bar7 feb
mouse3 dec
gizmo4 dec
gizmo6 dec
bar7 dec
click7 dec
bar4 dec
mouse7 aug
mouse3 aug
gizmo6 aug
gizmo4 aug
bar7 aug

click7	aug
bar4	aug
mouse7	apr
gizmo6	apr
mouse3	apr
gizmo4	apr
bar7	apr
click7	apr
bar4	apr
bar9	apr
click1	apr
click2	apr
click3	apr
click8	apr
click8	aug
bar9	aug
click2	aug
click3	aug
bar9	dec
click1	dec
click2	dec
click3	dec
click8	dec
click8	feb
bar9	feb
click1	feb
click2	feb
click3	feb
bar9	jan
click1	jan
click2	jan
click3	jan
click8	jan
bar9	jul
click1	jul
click2	jul
click8	jul
bar9	jun
click1	jun
click2	jun
click3	jun
click8	jun
click8	mar

bar9 mar
click1 mar
click2 mar
click3 mar
bar9 may
click1 may
click2 may
click3 may
click8 may
bar9 nov
click1 nov
click2 nov
click3 nov
click8 nov
bar9 oct
click1 oct
click2 oct
click3 oct
click8 oct
click8 sep
bar9 sep
click1 sep
click2 sep
click3 sep
click4 sep
click9 sep
gizmo1 sep
click9 oct
gizmo1 oct
mouse2 oct
click4 oct
click9 nov
gizmo1 nov
mouse2 nov
mouse2 sep
click4 nov
mouse2 may
click9 may
gizmo1 may
click4 may
click4 mar
click9 mar
gizmo1 mar

mouse2 mar
click9 jun
gizmo1 jun
mouse2 jun
click4 jun
click9 jul
gizmo1 jul
mouse2 jul
click4 jul
mouse2 jan
click9 jan
gizmo1 jan
click4 jan
mouse2 feb
click4 feb
click9 feb
gizmo1 feb
click9 dec
gizmo1 dec
mouse2 dec
click4 dec
mouse2 aug
click4 aug
click9 aug
gizmo1 aug
gizmo1 apr
click4 apr
mouse2 apr
mouse8 apr
bar2 aug
bar3 aug
bar2 apr
bar3 apr
mouse8 aug
bar2 dec
bar3 dec
mouse8 dec
bar2 feb
bar3 feb
mouse8 feb
bar2 jan
bar3 jan
mouse8 jan

bar2 jul
bar3 jul
mouse8 jul
bar2 jun
bar3 jun
mouse8 mar
bar2 may
bar3 may
mouse8 jun
bar2 mar
bar3 mar
mouse8 may
bar2 nov
bar3 nov
mouse8 sep
mouse8 nov
bar2 oct
bar3 oct
mouse8 oct
bar2 sep
bar3 sep
mouse9 oct
mouse4 oct
mouse9 nov
mouse4 nov
mouse9 sep
mouse4 sep
mouse9 may
mouse4 may
mouse9 jun
mouse9 mar
mouse4 mar
mouse9 jul
mouse4 jul
mouse4 jun
mouse9 jan
mouse4 jan
mouse9 feb
mouse4 feb
mouse9 dec
mouse4 dec
mouse9 aug
mouse4 aug

mouse9 apr
mouse4 apr
gizmo9 apr
gizmo5 apr
gizmo5 aug
gizmo9 aug
gizmo9 dec
gizmo5 feb
gizmo9 feb
gizmo5 jan
gizmo9 jan
gizmo9 jul
gizmo5 jul
gizmo9 jun
gizmo5 jun
gizmo9 mar
gizmo5 mar
gizmo9 may
gizmo5 may
gizmo9 sep
gizmo5 sep
gizmo9 nov
gizmo5 nov
gizmo9 oct
gizmo5 oct
gizmo8 oct
mouse5 oct
click6 sep
bar5 sep
gizmo8 nov
click6 nov
bar5 nov
mouse5 nov
click6 oct
bar5 oct
gizmo8 sep
mouse5 sep
gizmo8 may
click6 may
bar5 may
mouse5 may
gizmo8 mar
mouse5 mar

click6 mar
bar5 mar
gizmo8 jun
mouse5 jun
mouse5 jul
click6 jun
bar5 jun
gizmo8 jul
click6 jul
bar5 jul
gizmo8 jan
mouse5 jan
click6 jan
bar5 jan
click6 feb
gizmo8 feb
mouse5 feb
bar5 feb
mouse5 dec
gizmo8 dec
click6 dec
gizmo8 aug
click6 aug
mouse5 aug
bar5 dec
click6 apr
bar5 apr
gizmo8 apr
mouse5 apr
bar5 aug
bar6 aug
mouse6 apr
bar6 apr
click5 apr
gizmo2 apr
bar6 dec
click5 dec
mouse6 aug
gizmo2 aug
click5 aug
gizmo2 dec
mouse6 dec
bar6 feb

```
gizmo2     feb
click5     feb
mouse6     feb
bar6       jan
click5     jan
gizmo2     jan
mouse6     jan
click5     jul
bar6       jul
gizmo2     jul
bar6       jun
click5     jun
mouse6     jul
mouse6     jun
gizmo2     jun
bar6       mar
gizmo2     mar
click5     mar
mouse6     mar
mouse6     may
click5     nov
bar6       may
click5     may
gizmo2     may
mouse6     sep
bar6       oct
click5     oct
mouse6     nov
bar6       nov
gizmo2     nov
bar6       sep
gizmo2     sep
click5     sep
mouse6     oct
gizmo2     oct
*/
```