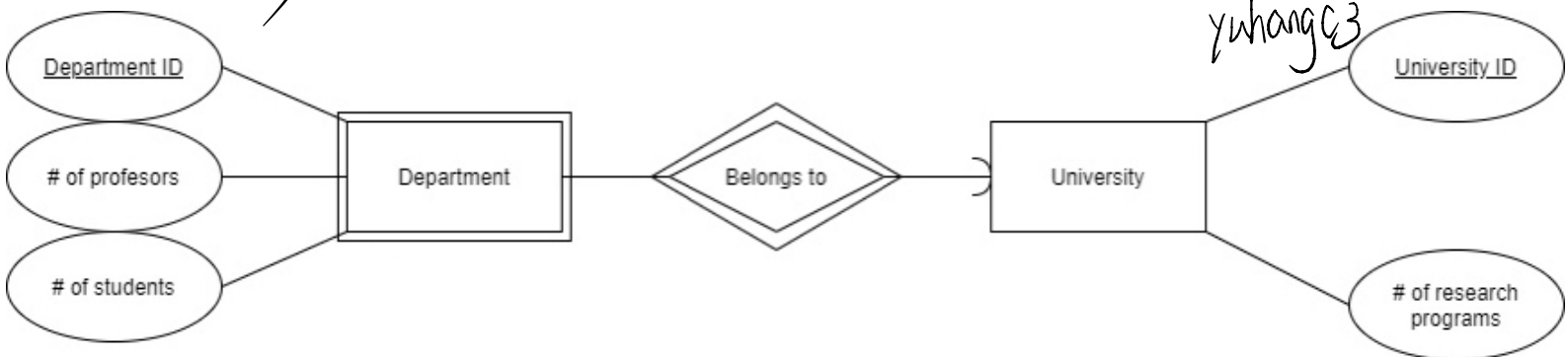
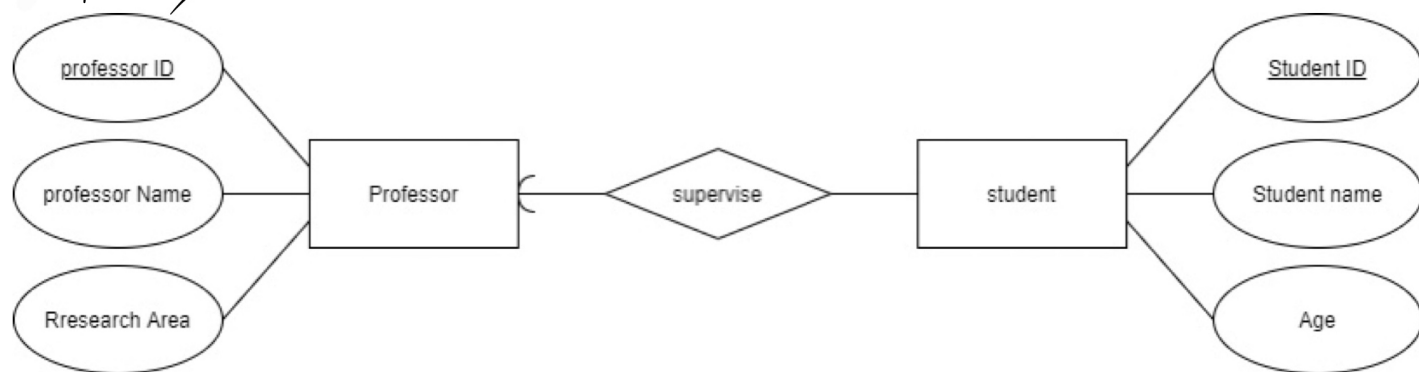


1.1 a)

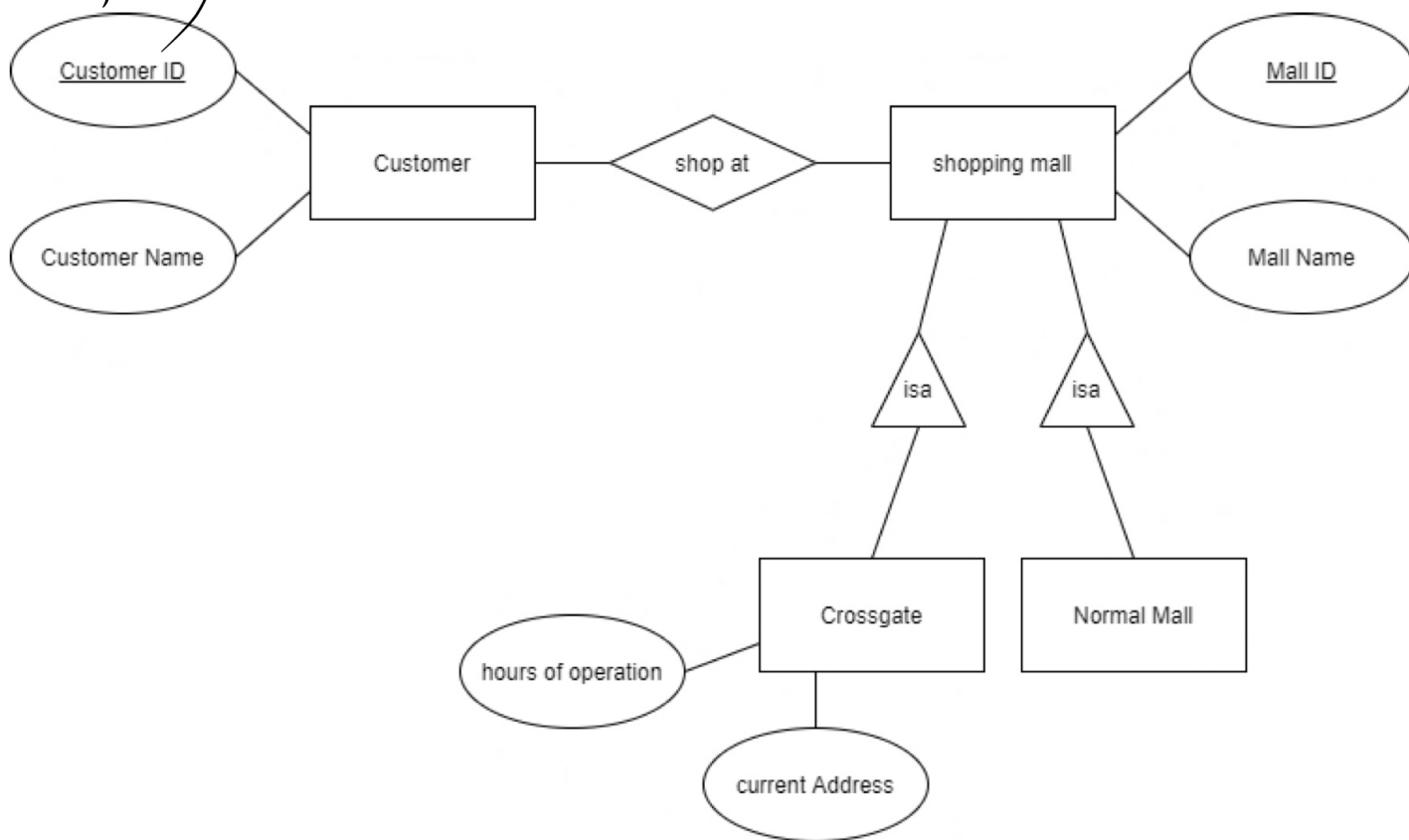
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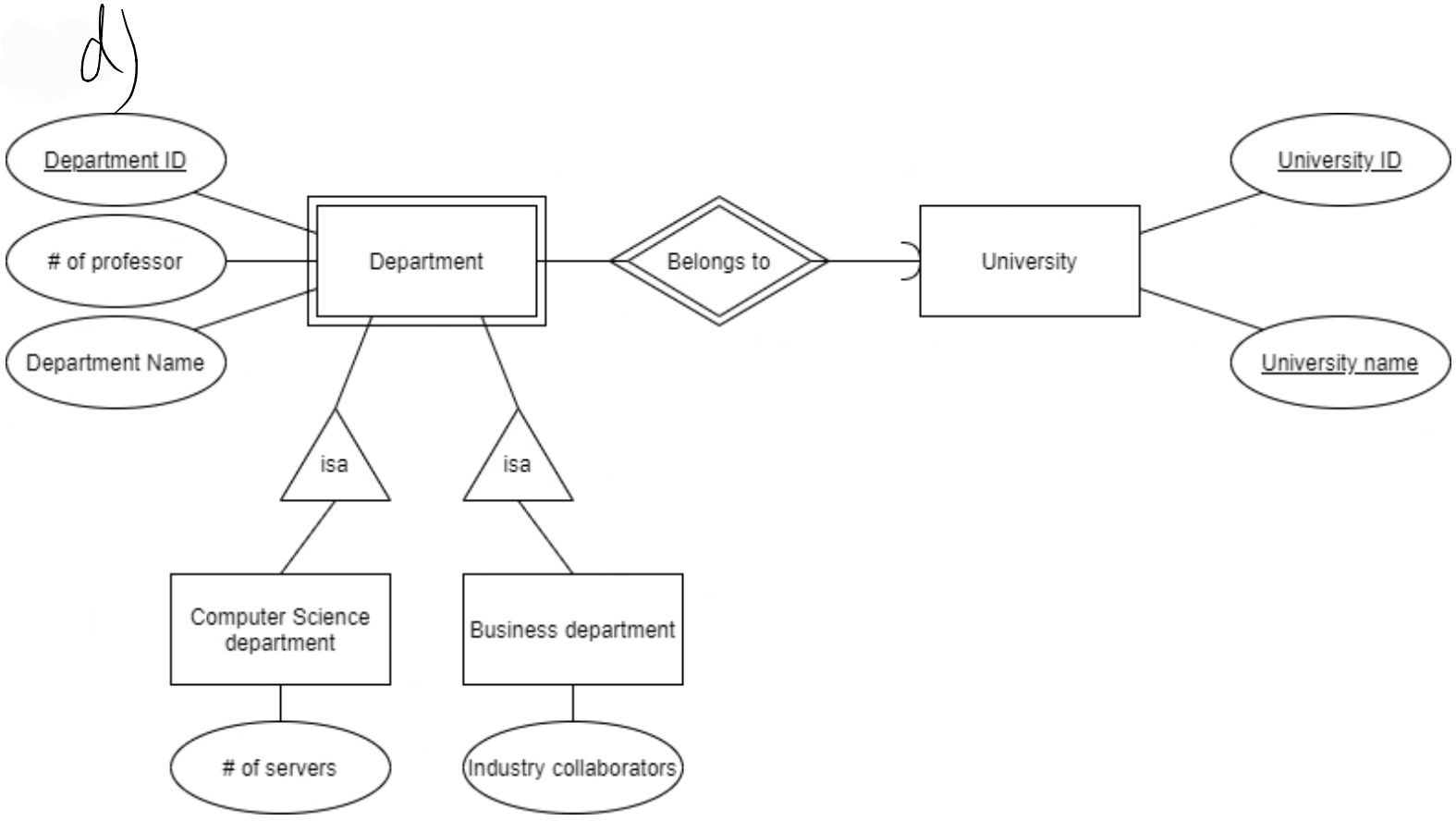


1.1. b)

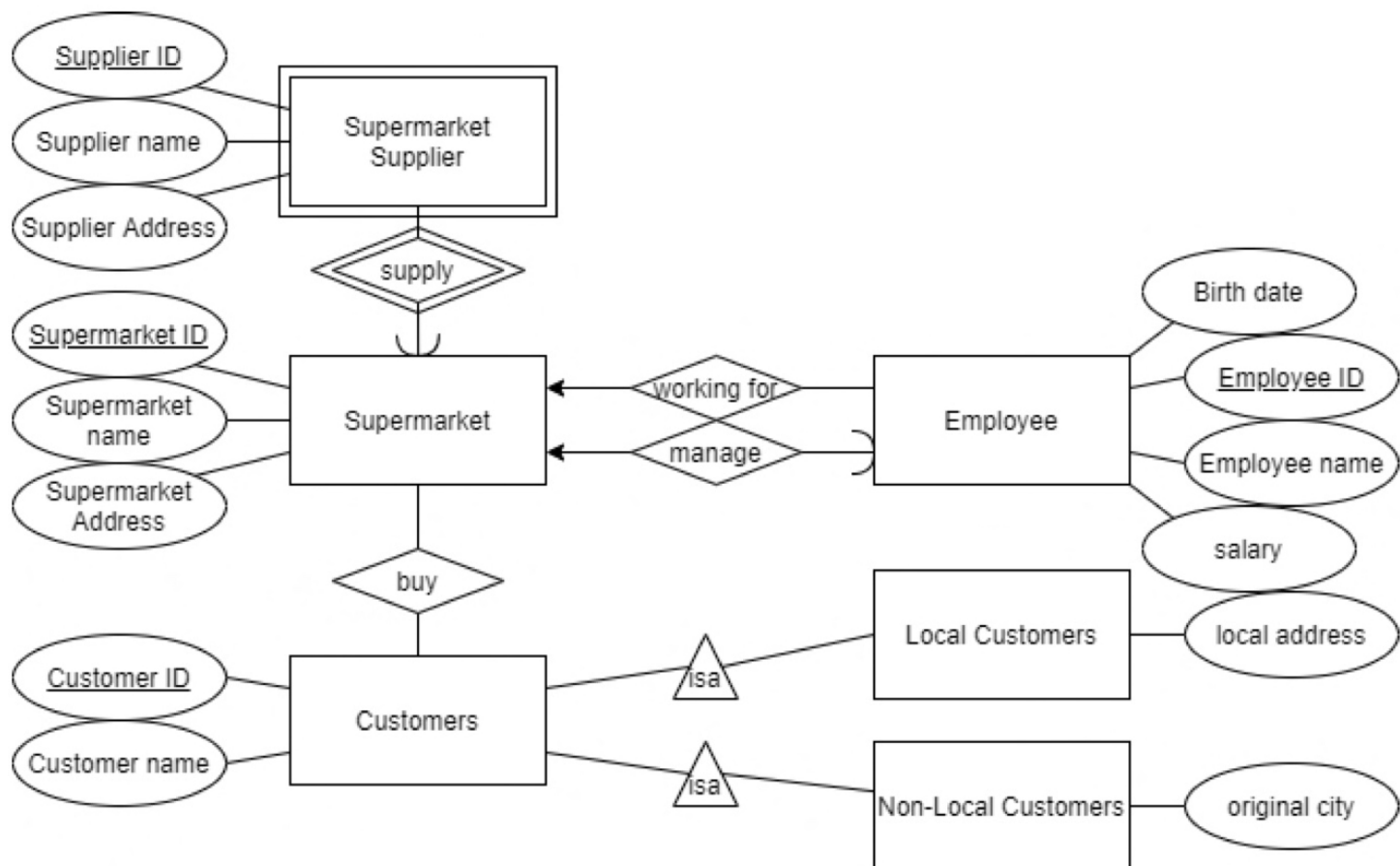


1.1 c)

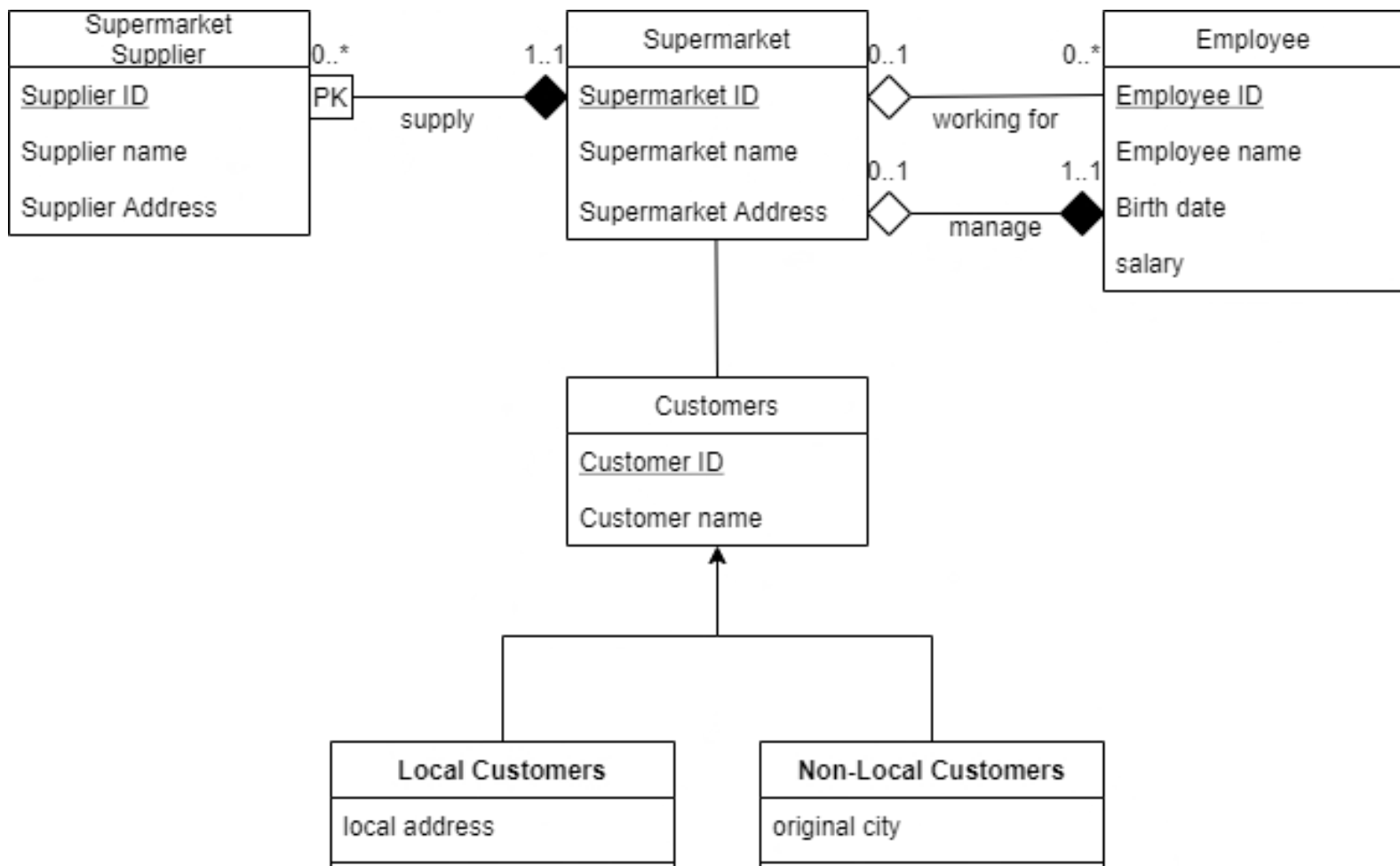




1-2.1



1.1.2



1.3a

1. True, the relationship between customer and restaurant is a many-many relation
2. False, the relationship between food and restaurant is a many-one relation, which means a certain food can only be served by one restaurant, but a restaurant can serve multiple food
3. False, the food is a weak entity need to be identified by its Name and its restaurant's name together.

1.3b

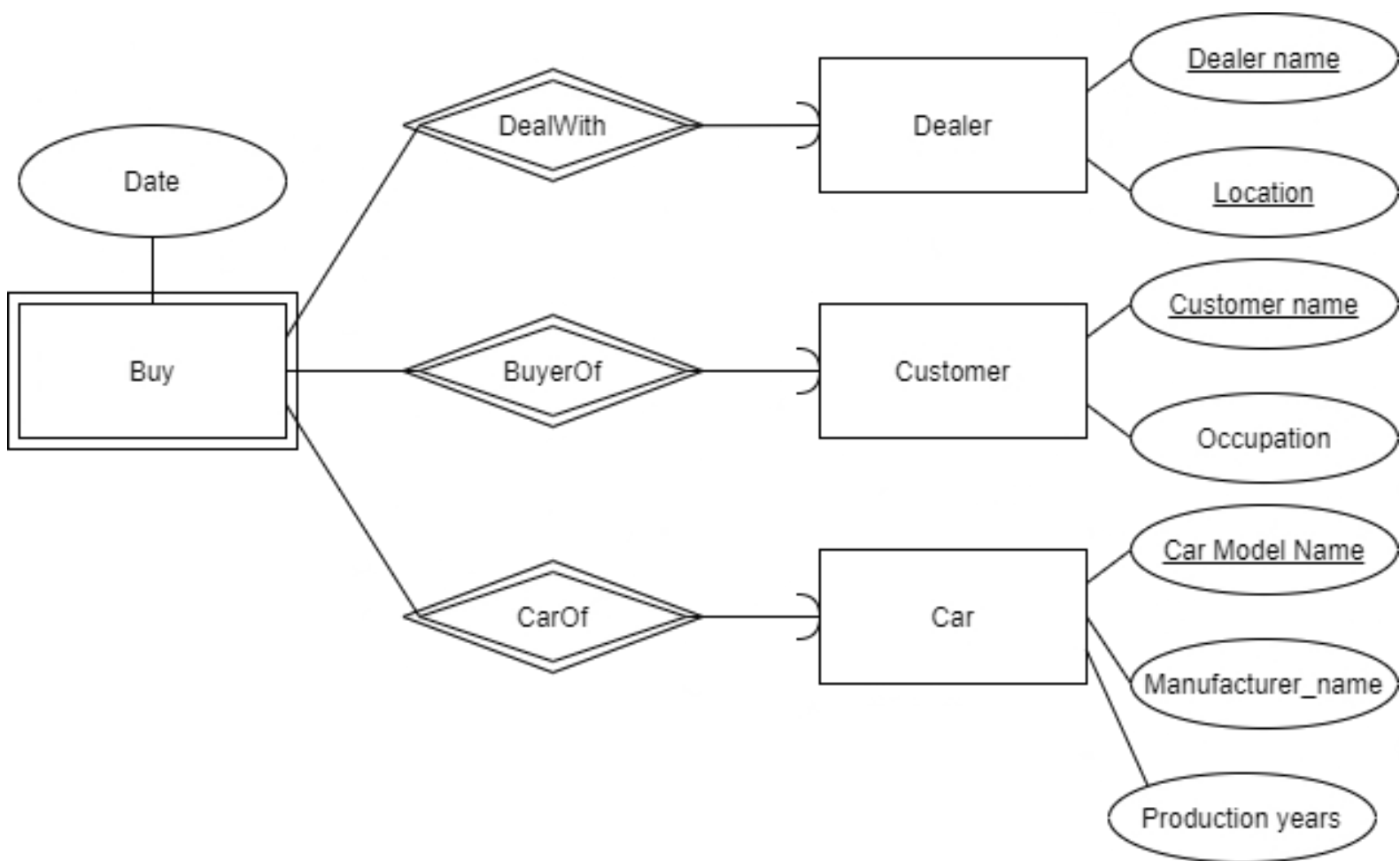
```
CREATE TABLE Customer (  
    Customer ID    INT NOT NULL,  
    Name           VARCHAR(255),  
    PRIMARY KEY (Customer ID)  
);
```

```
CREATE TABLE Restaurant (  
    Name           VARCHAR(255) NOT NULL,  
    Owner          VARCHAR(255),  
    PRIMARY KEY (Name)  
);
```

```
CREATE TABLE Food Item (  
    Name           VARCHAR(255) NOT NULL,  
    Price          REAL,  
    RestaurantName VARCHAR(255),  
    PRIMARY KEY (Name, RestaurantName),  
  
    FOREIGN KEY (RestaurantName) REFERENCES Restaurant (Name),  
    ON DELETE CASCADE,  
    ON UPDATE CASCADE  
);
```

```
CREATE TABLE Eats At (  
    Customer ID    INT NOT NULL,  
    Name           VARCHAR(255) NOT NULL,  
    Date           DATE,  
    Food Order     VARCHAR(255),  
    PRIMARY KEY (Customer ID, Name),  
  
    FOREIGN KEY (Name) REFERENCES Restaurant (Name),  
    ON DELETE CASCADE,  
    ON UPDATE CASCADE,  
    FOREIGN KEY (Customer ID) REFERENCES Customer (Customer ID),
```

1.4



2.5a

1. $\{F\}^+=\{F\}$
 $\{A,B\}^+=\{A,B,C,D,F\}$
 $\{C,E,F\}^+=\{A,B,C,D,E,F\}$
 $\{D\}^+=\{A,D\}$
 $\{A,C,D,F\}^+=\{A,C,D,F\}$
2. $\{A,E\}, \{C,E\}, \{D,E\}$

2.5b

- Step1: $A^+=A, B^+=AB, C^+=AC, D^+=D, E^+=AE$
 $AB^+=AB, AC^+=AC, AD^+=AD, AE^+=AE, BC^+=ABC, BD^+=ABD$
 $BE^+=ABE, CD^+=ACD, CE^+=ABCE, DE^+=ADE$
 $ABC^+=ABC, ABD^+=ABD, ABE^+=ABE, ACD^+=ACD, ACE^+=ABCE,$
 $ADE^+=ADE, BCD^+=ABCD, BCE^+=ABCE, BDE^+=ABDE, CDE^+=ABCDE$
 $ABCD^+=ABCD, ABCE^+=ABCE, ABDE^+=ABDE, ACDE^+=ABCDE,$
 $BCDE^+=ABCDE$
- Step2: $B \rightarrow A, C \rightarrow A, E \rightarrow A, BC \rightarrow A, BD \rightarrow A, BE \rightarrow A, CD \rightarrow A, CE \rightarrow AB, DE \rightarrow A$
 $ACE \rightarrow B, BCD \rightarrow A, BCE \rightarrow A, BDE \rightarrow A, CDE \rightarrow AB, ACDE \rightarrow B, BCDE \rightarrow A$

2.6a

1. Not BCNF since for FD $C \rightarrow B$, C is not a super key of R1
Not 3NF since for FD $C \rightarrow B$, C is not a super key of R1 and B is not part of a key
2. BCNF since $C^+=ABCDEF$ which is a super key and other FD all include C.
3NF since it is a BCNF
3. Not BCNF since for FD $B \rightarrow A$, $B^+=AB$ B is not a super key of R3
3NF for every FD, we find BF and AF is super keys, and for FD $B \rightarrow A$, A is part of a key and for $AC \rightarrow B$, B is part of a key

2.6b

1. Step1: $FD=\{E \rightarrow B, B \rightarrow A, E \rightarrow A, E \rightarrow D, AE \rightarrow B, BC \rightarrow D\}$
Step2: $FD=\{E \rightarrow B, B \rightarrow A, E \rightarrow A, E \rightarrow D, A \rightarrow B, BC \rightarrow D\}$
Step3: $FD=\{B \rightarrow A, E \rightarrow D, A \rightarrow B, BC \rightarrow D\}$
Final Answer: $\{B \rightarrow A, E \rightarrow D, A \rightarrow B, BC \rightarrow D\}$
2. Step1: We've already get min basis: $\{B \rightarrow A, E \rightarrow D, A \rightarrow B, BC \rightarrow D\}$
Step2: $\{AB\}, \{DE\}, \{BCD\}$
Step3: none of them are key of R, we add a key $\{BCE\}$
Final Answer: $\{AB\}, \{DE\}, \{BCD\}, \{BCE\}$

2.6c

Step1

$A \rightarrow A$, $B \rightarrow B$, $D \rightarrow AD$, $F \rightarrow ADF$, $AB \rightarrow AB$, $AD \rightarrow AD$, $AF \rightarrow ADF$, $BD \rightarrow ABD$,
 $BF \rightarrow ABDF$, $DF \rightarrow ADF$, $ABD \rightarrow ABD$, $ABF \rightarrow ABDF$, $ADF \rightarrow ADF$, $BDF \rightarrow ABDF$

Step2:

$D \rightarrow A$, $F \rightarrow AD$, $AF \rightarrow D$, $BD \rightarrow A$, $BF \rightarrow AD$, $DF \rightarrow A$, $ABF \rightarrow D$, $BDF \rightarrow A$

2.6c

1) A is not a super key, R is not BCNF

2) pick relation $A \rightarrow F$,

3) $BF \rightarrow BCDEF$

3) $R_1(BCDEF)$, $R_2(ABF)$

4) FDs for R_1 :

$B \rightarrow E$, $BF \rightarrow C$, $C \rightarrow D$, $C \rightarrow E$

5) B is not a super key

6) Pick relation $B \rightarrow E$

7) $B \rightarrow BE$

8) $R_{11}(BE)$, $R_{12}(BCDF)$

9) R_{11} is 2-attributes

10) FDs for R_{12}

$BF \rightarrow C$, $C \rightarrow D$

11) C is not a super key

12) pick $C \rightarrow D$

13) $C \rightarrow CD$

14) $R_{121}(CD)$, $R_{122}(BCF)$

15) R_{121} is 2-attribute, R_{122} has only DF: $BF \rightarrow C$ which BF is a super key

16) FD for R_2 :

$A \rightarrow F$

17) A is not a super key

18) Pick $A \rightarrow F$

19) $A \rightarrow AF$

20) $R_{21}(AF)$, $R_{22}(AB)$

21) both of them are 2-attributes

22) all relations are BCNF

Final answer $\{BE\}$ $\{CD\}$ $\{BCF\}$ $\{AF\}$ $\{AB\}$

ON DELETE CASCADE,
ON UPDATE CASCADE

)