**Functional Dependency**

***Exercise 1:*** *Consider a relation R(A, B, C, D, E) with the following dependencies:  
AB → C, CD → E, DE → B  
Find all possible keys of the relation.*

(A,B)+ = {A,B,C}

(ABD)+ = {A,B,C,D,E}

***Exercise 2:*** *Consider the universal relation R = {A, B, C, D, E, F, G, H, I, J} and the set of  
functional dependencies:  
A, B → C  
A → D, E  
B → F  
F → G, H  
D → I, J  
What is the key for R? Decompose R into 2NF, then 3NF relations.*

(AB)+ = {A,B,C,D,E,F,G,H,I,J}

**2NF:**

A *→* D,E (violated the 2NF)

B *→* F (violated the 2NF)

R1(A,D,E)

R2(B,F)

R3(A,B,C,G,H,I,J)

**3NF:**

A *→* D,E (valid)

B *→* F (valid)

R3(A,B,C,G,H,I,J) there is no transitive dependency

So the answer of 3NF is the same w 2NF

***Exercise 3:*** *Consider the universal relation R = {A, B, C, D, E, F, G, H, I, J} and the set of  
functional dependencies:  
A, B → C  
B, D → E, F  
A, D → G, H  
A → I  
H → J  
What is the key for R? Decompose R into 2NF, then 3NF relations.*

(A,B)+ = {A,B,C}

(ABD)+ = {A,B,D,C,E,F,G,H,I,J}

**2NF:**

A *→* I (violated the 2NF)

A,B *→* C (violated the 2NF)

B,D *→* E,F (violate the 2NF)

A,D *→* G,H (violate the 2NF)

R1(A,I)

R2(A,B,C)

R3(B,D,E,F)

R4(A,D,G,H)

R5(A,B,D,J)

**3NF:**

The answer also the same as 2NF

***Exercise 4:*** *Consider the relation R = {ShipName, ShipType, VoyageID, Cargo, Port, Date} and  
the set of functional dependencies:  
ShipName → ShipType  
VoyageID →ShipName, Cargo  
ShipName, Date → VoyageID, Port  
What is the key for R? Decompose R into 2NF, then 3NF relations.*

(Date, ShipName)+= {ShipType, ShipName,Cargo,VoyageID,Port}

**2NF:**

R1(ShipName, ShipType)

R2(ShipName, Date, Cargo, VoyageID, Port)

**3NF:**

R1(ShipName, ShipType)

R2\_1(VoyageID, Cargo)

R2\_2(ShipName, Date, Port, VoyageID)