CS281-Spring 2015 Week No. 12 class Days: April 21, 23

Note Takers: Gökhan Arıtürk, Serhat Ozan Altuntuğ, Melih Yücel

Irreducible(minimal) Sets Of Functional Dependencies

A set of functions is irreducible if and only if:

- **1.** The right hand side of every FD is a single attribute
- 2. We cannot replace FD X--> A with a FD Y-->A where Y is a proper subset of X and still have a set of F.D.'s equivalent to F.
- 3. We cannot remove any F.D. from F and still have a set of F.D.'s equivalent to F.

Algorithm:

- **1.** Set G:= F
- **2.** Replace each F.D. x-->A1, A2,A3 ,....An in G with FD's x-->A1, x-->A2,.... x-->An(decomposition).
- **3.** For every FD x-->A in G for each attribute B that is an element of x.

if $\{G-(x->A)\} \cup \{(X-B)-->A\}$ is equivalent to G, then replace X-->A with (X-B)-->A (simplify left sides).

4. For every remaining FD x-->A in G, if {G-(X-->A)} is equivalent to G then remove X--A from G.

Example:

F ={ A-->BC, B-->C, A-->B, AB-->C, AC-->D}

- **1.** G:=F
- **2.** G: { A-->BC, B-->C, A-->B, AB-->C, AC-->D}
- **3.** AC-->D can be replaced

G= {A-->B,A-->C,B-->, A-->D}

4. A-->C is implied (A-->B, B-->C); so drop A-->C G = {A-->B, B-->C, A-->D}

Boyce Code Normal Form

A relation R is in BCNF if for every FD x-->Y associated with R is either:

- **1.** $Y \subset X$ (*i.e.* the FD is trivial
- 2. X is a super key of R.

Example: Person1(<u>ssn</u>,name,address)

The only F.D is ssn--> name, address(ssn-->name,ssn--address)

ssn is key(superkey) so Person1 is in BCNF.

1NF,2NF,3NF,BCNF

1NF: each attribute is atomic

student(ssn,	name,	dept,	hobbies)
s1, s2,	ahmet, oya,	cs, ie,	reading/music/cooking karate/hiking
student1(ssn,	sname,	dept,	hobby)
s1,	ahmet,	CS,	music
s1,	ahmet,	CS,	music
s1,	ahmet,	CS,	cooking
s2,	oya,	IE,	karate
s2,	oya,	IE,	hiking

Red tuples are redundant.



Now, we can easily add a student with no hobby. If a student changes dept, make the only tuple.

Irreduciable (Minimal) Sets of Functional Dependencies

A set of F of FDs is irreduciable if

1. The right-hand side of every FD is a single attribute

2. We cannot replace FD X \longrightarrow A with a FD Y-A where Y is a proper subset of X(Y C X) and still have a set of FDs equivalent to F.

3. We cannot remove any FD from F and still have a set of FDs equivalent to F.

Algorithm:

1. Set G:=F

2. Replace each FD X \rightarrow A1, X \rightarrow A2...,X \rightarrow An (decomposition)

3. For every FD X \longrightarrow A in G for each attribute B that is an element of X

 $\{\underline{if} (G-\{X-A\}U \{(X-B) \longrightarrow A\} \text{ is equivalent to } G \text{ then replace } X \longrightarrow A \text{ with } (X-B) \longrightarrow A (simplify left sides)$

4. For every remaining FD X \longrightarrow A in G

{if (G-(X-A)) is equivalent to G then remove $X \longrightarrow A$ from G (remove all redundant ones)

Example.

 $F = \{A \longrightarrow BC, B \longrightarrow C, A \longrightarrow B, AB \longrightarrow C, AC \longrightarrow D\}$

1. G:=F

2. G: {A \rightarrow BC, B \rightarrow C, A \rightarrow B, AB \rightarrow C, AC \rightarrow D}

3. AC \rightarrow D can be replaced G={A \rightarrow B, A \rightarrow C, B \rightarrow C, A \rightarrow D}

4. A \rightarrow C is implied (A \rightarrow B, B \rightarrow C) so drop A \rightarrow C G={A \rightarrow B, B \rightarrow C, A \rightarrow D}

BCNF= Boyce Codd Normal Form

A relation R is in BCNF if for every FD X-Y associated with R is either

1. Y \underline{C} X (i.e., the FD is trivial)

2. X is a super key of R

Example. Person1(ssn, name, address)

The only FD is ssn→name, address

Ssn is key (superkey) so Personl is in BCNF

1NF, 2NF, 3NF, BCNF

1NF: each attribute is atomic

Student(ssn, name, dept, hobbies)

S 1	ahmet	cs	reading, music, cooking
S2	oya	ie	karate, hiking

Student1(ssn, sname, dept, hobby)



Student1(<u>ssn</u>, sname.dept)

student2(ssn, hobby)

S 1	ahmet cs	S 1	reading
S2	oya ie	S 1	music
S 3	zeynepie	S 1	cooking
+		S 2	karate
		S 2	hiking
/		S 3	reading

We can easily add a student with no hobby

If a student changes dept make the only one tuple