Tutorial 5: Logical Database Design

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`StudentInfo(S, N, M, A, C, T, I, L, G)`

with the following FDs:

1. S -> N

2. C -> T, I

3. I -> L

4. S, C, M -> G

5. S, M -> A

6. A -> M

1 Find all keys and prove that you have found them all.

Since `S` and `C` do not appear in any RHS of the FDs,
`S` and `C` must be part of every key.
$(S\ C)^+ = $ S C N T I L so (S C) is not a key.

Guess (S C M) and (S C A) are keys.
$(S\ C\ M)^+ = $ (S C M N T I L G A) = SI so (S C M) is a superkey.
$(S\ C\ A)^+ = $ (S C A N T I L G M) = SI so (S C A) is a superkey.
Since (S C) is not a key, so (S C M) and (S C A) are minimal, so they are keys.

Consider the maximal set $X \subseteq$ (S N M A C T I L G) such that (S C) $\subset$ X
and A, M $\notin$ X. The maximal such X is (S N C T I L G)
$X^+ = $ (S N C T I L G)$^+ = $ (S N C T I L G) $\neq$ SI

Therefore, (S C M) and (S C A) are the only keys for the relation SI.

2   Find a minimal cover for this set of FDs.

1. Put the FDs in a Standard Form.
2. Minimize the Left Side of Each FD.
3. Delete Redundant FDs.
So the minimum cover for this set of FDs is:

1. `S -> N`

2. `C -> T`

3. `C -> I`

4. `I -> L`

5. `S, C, M -> G`

6. `S, M -> A`

7. `A -> M`

3   Obtain a lossless-join, BCNF decomposition of StudentInfo.

For FD (1), we decompose `SI` to
`S1 = (S N)`
`S2 = (S M A C T I L G)`

For FD (3), we decompose `S2` to
`S3 = (I L)`
`S4 = (S M A C T I G)`

For FD (2), we decompose `S4` to
`S5 = (C T I)`
`S6 = (S M A C G)`

For FD (4), we decompose `S6` to
`S7 = (S C M G)`
`S8 = (S C M A)`

For FD (6), we decompose `S8` to
`S9 = (A M)`
`S10 = (S C A)`

Note that FD (5) cannot be applied to S10, the decomposition is done. So the final decomposition of StudentInfo is:
`S1 = (S N)`
`S3 = (I L)`
`S5 = (C T I)`

```
S7 = (S C M G)
S9 = (A M)
S10 = (S C A)
```

4   Obtain a lossless-join, dependency-preserving, 3NF decomposition of StudentInfo by making use of the BCNF decomposition in Question (c).

The BCNF decomposition we obtained from (c) is:
```
S1 = (S N)
S3 = (I L)
S5 = (C T I)
S7 = (S C M G)
S9 = (A M)
S10 = (S C A)
```
The FD (5): `S, M -> A` is not preserved, so we add `S11 = (S M A)`.
So the final 3NF decomposition is:
```
S1 = (S N)
S3 = (I L)
S5 = (C T I)
S7 = (S C M G)
S9 = (A M)
S10 = (S C A)
S11 = (S M A)
```

5   Obtain a lossless-join, dependency-preserving, 3NF decomposition of StudentInfo via synthesis by making use of your minimal cover in Question (b).

The relations obtained from a minimum cover set is:
```
R1 = (S N)
R2 = (C T)
R3 = (C I)
R4 = (I L)
R5 = (S C M G)
R6 = (S M A)
R7 = (A M)
```

R3 and R4 can joint to (C I L), which can join R2 join to (C T I L), which can join R5 to (S C T I L M G)

6 **Comment on the differences, if any, between your answers to Questions (d) and (e).**