3NF Examples

<ex> Supplier (S#, Sname, Quantity, City)

- If \( F = \{ S\# \rightarrow S\text{name}, S\# \rightarrow Q, S\# \rightarrow \text{City} \} \), then 3NF
  - only key is \( S\# \)

- If \( F = \{ S\# \rightarrow S\text{name}, S\# \rightarrow Q, S\# \rightarrow \text{City}, C \rightarrow Q \} \), then not in 3NF
  - why? \( S\# \rightarrow \text{City}, \text{City} \not\rightarrow S\#, C \not\rightarrow Q, Q \notin \{ S\#, C \} \)
  - split: \( R_1 = (S\#, \text{Sname}, \text{City}) \), \( R_2 = (\text{City}, \text{Quantity}) \)

<ex> \( R = (\text{Flight}, \text{From}, \text{To}, \text{Departs}, \text{Arrives}, \text{Duration}, \text{Type}, \text{First-class}, \text{Coach}, \text{Total-seats}, \#\text{meals}) \)

Keys: \( \text{Flight} \rightarrow \text{R}, \text{From} \rightarrow \text{To} \rightarrow \text{R}, \text{From To Arrives} \rightarrow \text{R} \)

FD = \{ \text{Type} \rightarrow \text{First, Coach, Total-seats}, \text{Departs Duration} \rightarrow \#\text{meals}, \text{Arrives Duration} \rightarrow \#\text{meals}, \text{First Coach} \rightarrow \text{Total-seats}, \text{First Total} \rightarrow \text{Coach}, \text{Coach Total} \rightarrow \text{First} \}

3NF Examples (Cont’d)

In the example, \( R \) is not in 3NF (transitive dependencies)

1) Eliminate TD: \( \text{Flight} \rightarrow \text{Departs Duration} \rightarrow \#\text{meals} \)
   \( R_1 = (\text{Flight, From, To, Departs, Arrives, Duration, Type, First-class, Coach, Total-seats}) \)
   with \( K_1: \text{Flight, From To Departs, From To Arrives} \)
   \( R_2 = (\text{Departs, Duration, #meals}) \)
   with \( K_2: \text{Departs Duration} \)
   \( R_2 \) is in 3NF, but \( R_1 \) is not

2) Eliminate TD: \( \text{Flight} \rightarrow \text{Type} \rightarrow \text{First-class, Coach, Total-seats} \)
   \( R_{11} = (\text{Flight, From, To, Departs, Arrives, Duration, Type}) \)
   with \( K_{11}: \text{Flight, From To Departs, From To Arrives} \)
   \( R_{12} = (\text{Type, First-class, Coach, Total-seats}) \)
   with \( K_{12}: \text{Type} \)

Now every relation is in 3NF:
\( R = \{ R_{11}, R_{121}, R_{122}, R_2 \} \) is in 3NF

Furthermore,
\( r = \Pi_{R_{11}}(r) \mid (\Pi_{R_{121}}(r) \mid (\Pi_{R_{122}}(r) \mid (\Pi_{R_2}(r)))) \mid (\Pi_{R_2}(r)) \)

- Decomposition is not unique
  - at the first step, we may choose
    \( R_2 = (\text{Arrives, Duration, #meals}) \)
  - may end up creating more relation schemes than really needed for 3NF, by introducing partial dependencies through decomposition