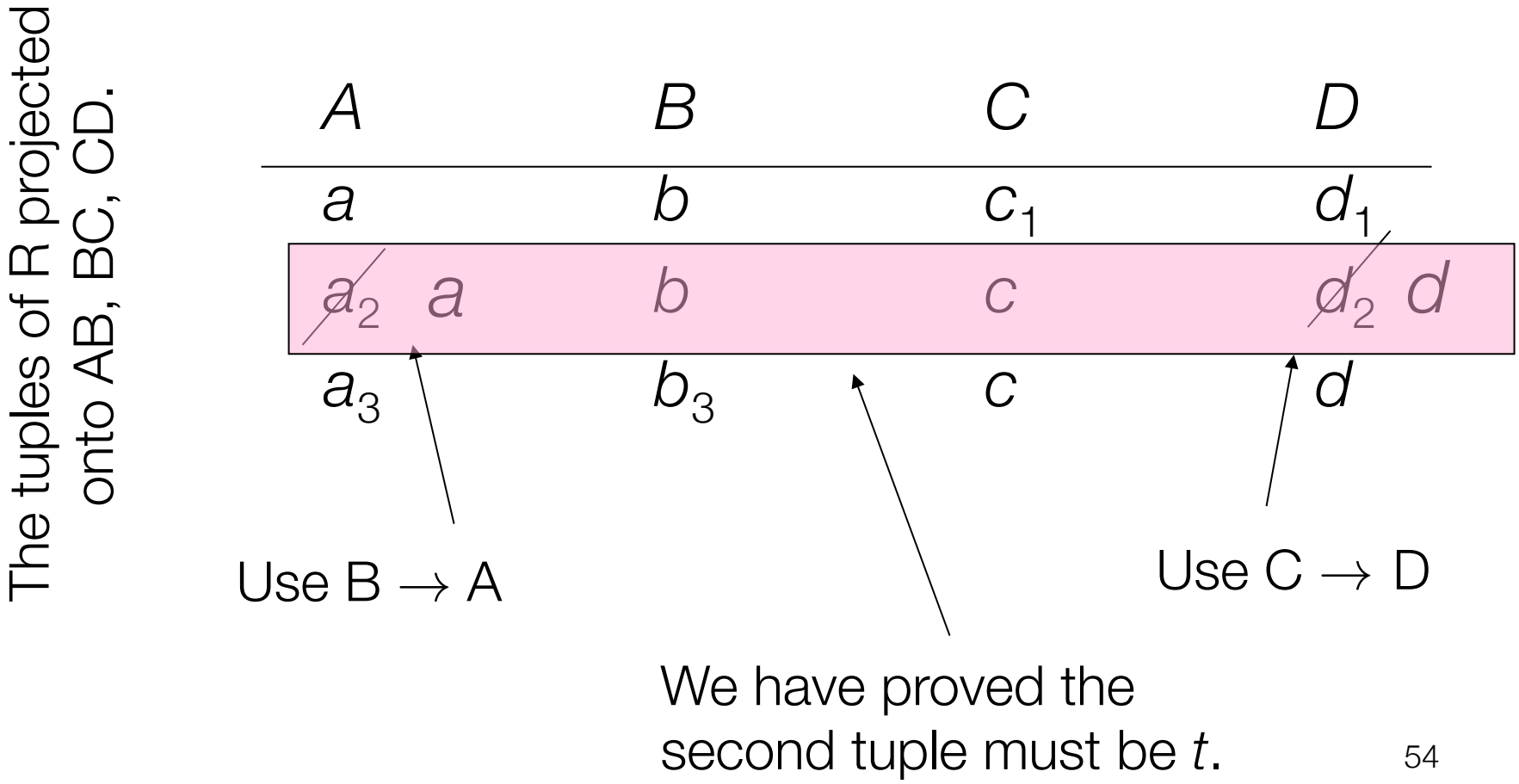
Example: Chase test

- Let R = ABCD
  - Assume the decomposition is R_1=AB, R_2=BC, R_3=CD
  - Let the set of FDs be C $\rightarrow$ D and B $\rightarrow$ A
- Suppose the tuple t = abcd is the join of tuples projected onto AB, BC, CD
- What happens when we lay down the three different tuples s_i?

The Tableau


The tuples of R projected onto AB, BC, CD.
A
B
C
D
a
b
c_1
d_1
a_2 a
b
c
d_2 d
a_3
b_3
c
d
Use B → A
Use C → D
We have proved the second tuple must be t.

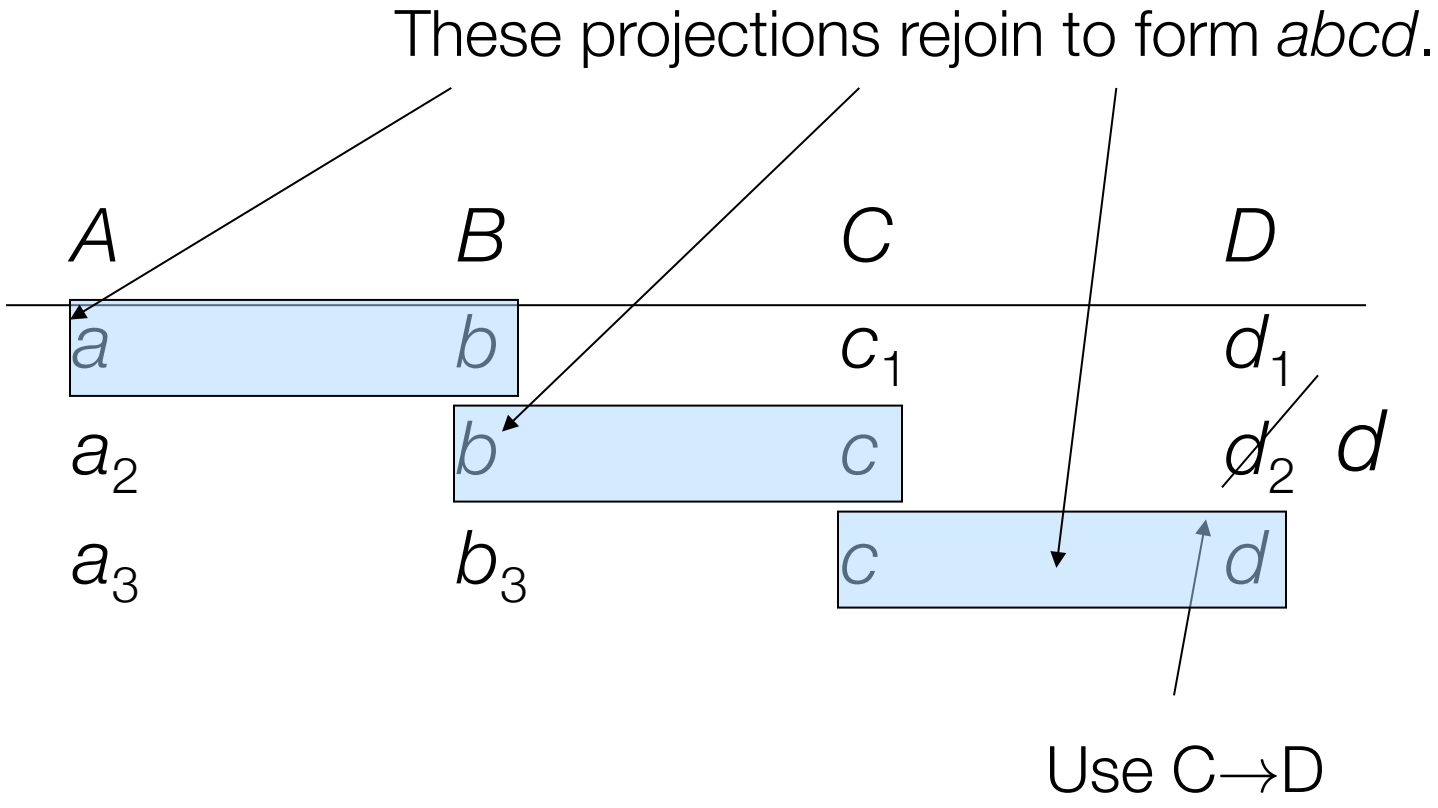
Summary of the chase

1. If two rows agree in the left side of a FD, make their right sides agree too.
2. Always replace a subscripted symbol by the corresponding unsubscripted one, if possible.
3. **If we ever get an unsubscripted row, we know any tuple in the project-join is in the original (i.e., the join is lossless).**
4. Otherwise the final table acts as a counter-example.

Example: Chase test with a lossy join

- Use the same relation R = ABCD
  - Assume the same decomposition R_1=AB, R_2=BC, R_3=CD
  - But now our only FD is C $\rightarrow$ D (i.e., ~~B $\rightarrow$ A~~)
- Let us look at the tableau again...

The Tableau



These three tuples are an example R that shows the join is lossy. *abcd* is not in the tableau, but we can project and rejoin to get *abcd* (and more).

3NF Synthesis (1)

- By decomposing into 3NF relations, we can always produce a result that:
  - has a lossless join and
  - preserves dependencies.
- To proceed, however, we need to construct a **minimal basis** of the FDs (i.e., a
  1. Right sides are single attributes.
  2. No FD can be removed (and still have a basis).
  3. No attribute can be removed from a left side (and still have a basis).
- (Note that a trivial FD cannot be part of a minimal basis due to rule 2.)

Constructing a minimal basis

1. Split all right-hand sides
2. Repeatedly try to remove an FD and see if the remaining FDs are equivalent to the original.
3. Repeatedly try to remove an attribute from a left side and see if the resulting FDs are equivalent to the original

3NF Synthesis (2)

- (Assuming here that our minimal basis also includes FDs that are not in 3NF...)
- We construct one schema for each FD in the minimal basis
  - Schema is the union of the left- and right-hand sides
- If no key or superkey is contained in an FD...
  - ... then add one relation whose schema is some key.

Example: 3NF Synthesis

- Relation R = ABCD
- FDs: A $\rightarrow$ B, A $\rightarrow$ C
- Decomposition:
  - AB (from the FD)
  - AC (from the FD)
  - AD (to add a key as there is none within the FDs)