Plan for Today

1. Class worksheet from last time (lossless testing)
2. Dependency-preserving decompositions
3. Algorithm for 3NF decomposition
4. Recap
5. NoSQL – Part 1
{A, B, C, D}  A → B, B → C, D → A

Show executions of the algorithm for testing whether the following decompositions are lossless:

1. AB, BC, CD
2. AB, BC, AD
{A,B,C,D}  A→B, B→C, D→A

AB, BC, CD

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>a2</td>
<td></td>
<td>x_{13}</td>
<td>x_{14}</td>
</tr>
<tr>
<td>x_{21}</td>
<td>a2</td>
<td></td>
<td>a3</td>
<td>x_{24}</td>
</tr>
<tr>
<td>x_{31}</td>
<td></td>
<td>x_{32}</td>
<td>a3</td>
<td>a4</td>
</tr>
</tbody>
</table>
Question 1 (a)

\[(A, B, C, D) \quad A \rightarrow B, \quad B \rightarrow C, \quad D \rightarrow A\]

AB, BC, CD

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a1</td>
<td>a2</td>
<td>a3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x_{21}</td>
<td>a2</td>
<td>a3</td>
<td>x_{14}</td>
</tr>
<tr>
<td></td>
<td>x_{31}</td>
<td>x_{32}</td>
<td>a3</td>
<td>a4</td>
</tr>
</tbody>
</table>
Question 1 (a)

\[(A,B,C,D) \quad A \rightarrow B, \quad B \rightarrow C, \quad D \rightarrow A\]

\[AB, \ BC, \ CD\]

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>a1</td>
<td>a2</td>
<td>a3</td>
<td>x_{14}</td>
</tr>
<tr>
<td>x_{21}</td>
<td>a2</td>
<td>a3</td>
<td>x_{24}</td>
<td></td>
</tr>
<tr>
<td>x_{31}</td>
<td>x_{32}</td>
<td>a3</td>
<td>a4</td>
<td></td>
</tr>
</tbody>
</table>
**Question 1 (b)**

\[(A,B,C,D) \quad A \rightarrow B, \quad B \rightarrow C, \quad D \rightarrow A\]

**AB, BC, AD**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>a2</td>
<td></td>
<td>x_{13}</td>
<td>x_{14}</td>
</tr>
<tr>
<td>x_{21}</td>
<td>a2</td>
<td></td>
<td>a3</td>
<td></td>
</tr>
<tr>
<td>a1</td>
<td></td>
<td>x_{32}</td>
<td>x_{33}</td>
<td>a4</td>
</tr>
</tbody>
</table>
(A, B, C, D)  \( A \rightarrow B, B \rightarrow C, D \rightarrow A \)

AB, BC, AD

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>a2</td>
<td>x_{13}</td>
<td>x_{14}</td>
<td></td>
</tr>
<tr>
<td>x_{21}</td>
<td>a2</td>
<td>a3</td>
<td>x_{24}</td>
<td></td>
</tr>
<tr>
<td>a1</td>
<td>a2</td>
<td>x_{33}</td>
<td>a4</td>
<td></td>
</tr>
</tbody>
</table>
Question 1 (b)

(A,B,C,D)  \( A \rightarrow B, \ B \rightarrow C, \ D \rightarrow A \)

**AB, BC, AD**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>a2</td>
<td>x_{13}</td>
<td>x_{14}</td>
<td></td>
</tr>
<tr>
<td>x_{21}</td>
<td>a2</td>
<td>a3</td>
<td>x_{24}</td>
<td></td>
</tr>
<tr>
<td>a1</td>
<td>a2</td>
<td>a3</td>
<td>a4</td>
<td></td>
</tr>
</tbody>
</table>
Question 2 (a)

(A,B,C,D)  A→B , B→C , AD→C, D→A
Question 2 (a)

(A,B,C,D)  \( A \rightarrow B, B \rightarrow C, AD \rightarrow C, D \rightarrow A \)

Step 1: Minimal Cover

\( A \rightarrow B, B \rightarrow C, AD \rightarrow C, D \rightarrow A \)

\[ \downarrow \]

\( A \rightarrow B, B \rightarrow C, AD \rightarrow C, D \rightarrow A \)

Step 2: FDs to decomposition

\{AB, BC, DA\}

superkey
Question 2 (b)

(A,B,C,D,E)  ABC→D, D→BC, B→C, E→A
Question 2 (b)

\[(A,B,C,D,E) \quad ABC \rightarrow D, \ D \rightarrow BC, \ B \rightarrow C, \ E \rightarrow A\]

Step 1: Minimal Cover

\[
\begin{align*}
ABC \rightarrow D, \ D \rightarrow BC, \ B \rightarrow C, \ E \rightarrow A \\
\downarrow \\
ABC \rightarrow D, \ D \rightarrow B, \ D \rightarrow C, \ B \rightarrow C, \ E \rightarrow A \\
\downarrow \\
ABC \rightarrow D, \ D \rightarrow B, \ \xmark D \rightarrow C, \ B \rightarrow C, \ E \rightarrow A \\
\downarrow \\
ABC \rightarrow D, \ D \rightarrow B, \ \xmark \xmark \xmark \xmark \xmark \\
\downarrow \\
AB \rightarrow D, \ D \rightarrow B, \ B \rightarrow C, \ E \rightarrow A
\end{align*}
\]
(A,B,C,D,E)  ABC→D, D→BC, B→C, E→A

Step 2: FDs to decomposition

AB→D, D→B, B→C, E→A

↓

ABD, DB, BC, AE

Step 3: Add key

↓

ABD, DB, BC, AE, DE

Step 4: Remove contained

↓

ABD, BC, AE, DE
Recap

Database Design
- ERD
- Schema normalization
- Constraints/ FDs
- Foundations of Relational Databases

Database Queries
- RA
- SQL
- Queries in Logic

Next:
- NOSQL
- XML
- Semantic Web