Exercise 7

1 Anomalies

Consider the following instance gameRelease with relation schema GameRelease(Developer, Game, Platform, ReleaseYear). The primary key is (Game, Platform). Assume that the relation schema and thus, the instance are in 1NF, but not in 2NF.

<table>
<thead>
<tr>
<th>Developer</th>
<th>Game</th>
<th>Platform</th>
<th>ReleaseYear</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Zenimax Online Studios'</td>
<td>'Elder Scrolls Online'</td>
<td>'PC/Mac'</td>
<td>2014</td>
</tr>
<tr>
<td>'Zenimax Online Studios'</td>
<td>'Elder Scrolls Online'</td>
<td>'Xbox'</td>
<td>2015</td>
</tr>
<tr>
<td>'Arkane Studios'</td>
<td>'Dishonored 2'</td>
<td>'PC/Mac'</td>
<td>2016</td>
</tr>
<tr>
<td>'Lucas Arts'</td>
<td>'Monkey Island'</td>
<td>'DOS'</td>
<td>1990</td>
</tr>
</tbody>
</table>

For each of the following tasks, use instance gameRelease as given above.

1. Insert anomaly
   (a) Give a DML statement that leads to an insert anomaly in instance gameRelease.
   (b) Explain shortly, but precisely why your statement leads to an insert anomaly. State all your assumptions.

2. Update anomaly
   (a) Give a DML statement that leads to an update anomaly in instance gameRelease.
   (b) Explain shortly, but precisely why your statement leads to an update anomaly. State all your assumptions.

3. Delete anomaly
   (a) Give a DML statement that leads to a delete anomaly in instance gameRelease.
   (b) Explain shortly, but precisely why your statement leads to a delete anomaly. State all your assumptions.

2 Relational Database Design

1. Consider the following instance exhibition. A painting’s exhibition location (attribute Location) consists of the museum (attribute Museum) and the year of the exhibition (attribute ExhibitionYear).

<table>
<thead>
<tr>
<th>Painter</th>
<th>Painting</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miro</td>
<td>'The Singing Fish'</td>
<td>{'Kunsthaus Zurich', 2015}, ('Guggenheim', 2016)</td>
</tr>
<tr>
<td>Miro</td>
<td>' Constellation '</td>
<td>{'Kunsthaus Zurich', 2016}</td>
</tr>
</tbody>
</table>
Relation schema *Exhibition* has the following functional dependencies:

\[ F_e = \{ \\
\text{Painting} \rightarrow \text{Painter}, \\
\text{Painting}, \text{ExhibitionYear} \rightarrow \text{Museum} \\
\} \]

(a) Determine the set \( S_e \) of all candidate keys for relation schema *Exhibition*.

(b) Determine the highest normal form (no NF, 1NF, 2NF, 3NF) that relation schema *Exhibition* is in. Explain your answer.

(c) Transform instance exhibition into a new instance that satisfies the next higher normal form. Preserve all functional dependencies.

(d) Show the minimal set of functional dependencies for the transformed instance.

(e) List the candidate keys of the transformed instance.

2. Consider the following instance \( r \) with relation schema \( R = (A, B, C, D) \). Assume that all attributes of the relation schema are not multivalued, are not composite, and do not contain nested relations.

\[
\begin{array}{cccc}
A & B & C & D \\
r_1 & x & 1 & a & 5 \\
r_2 & y & 2 & b & 6 \\
r_3 & x & 3 & a & 5 \\
\end{array}
\]

Relation schema \( R \) has the following functional dependencies:

\[ F_r = \{ \\
D \rightarrow C, \\
C \rightarrow AD, \\
B D \rightarrow A, \\
\} \]

(a) Determine the set \( S_r \) of all candidate keys for relation schema \( R \).

(b) Determine the highest normal form (no NF, 1NF, 2NF, 3NF) that relation schema \( R \) is in. Explain your answer.

(c) Transform instance \( r \) into new instances that satisfy the next higher normal form. Preserve all functional dependencies.

(d) Show the minimal set of functional dependencies for the transformed instances.

(e) List the candidate keys of the transformed instances.