1. Third Normal Form

2. Boyce-Codd Normal Form

3. Assignment
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Definition (Transitive Dependence)

A set of attributes $Z$ is **transitively dependent** on a set of attributes $X$ if there exists a set of attributes $Y$ such that $X \rightarrow Y$ and $Y \rightarrow Z$.

Definition (Third Normal Form)

A relation $R$ is in **third normal form** (3NF) if it is in 2NF and there is no nonprime attribute of $R$ that is transitively dependent on any key of $R$.

- 3NF is violated if there is a nonprime attribute $A$ that depends on something less than a key.
Table 3 is in 2NF, but it is not in 3NF because

\[ \text{[order_no]} \rightarrow \text{[cust_no]} \rightarrow \text{[cust_name]}. \]
To put a relation into 3NF, for each set of transitive function dependencies $X \rightarrow Y \rightarrow Z$, make two tables, one for $X \rightarrow Y$ and another for $Y \rightarrow Z$. 

The four tables above are in 3NF.
1. Third Normal Form

2. Boyce-Codd Normal Form

3. Assignment
A relation $R$ is in **Boyce-Codd normal form** (BCNF) if for every nontrivial functional dependency $X \rightarrow A$, $X$ is a superkey of $R$.

That is, no attribute (prime or nonprime) depends on anything less than a superkey.
<table>
<thead>
<tr>
<th>Bldg</th>
<th>Room</th>
<th>Start</th>
<th>End</th>
<th>Prof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagby</td>
<td>111</td>
<td>9:30</td>
<td>10:20</td>
<td>Valente</td>
</tr>
<tr>
<td>Bagby</td>
<td>020</td>
<td>10:30</td>
<td>11:20</td>
<td>Koether</td>
</tr>
<tr>
<td>Bagby</td>
<td>020</td>
<td>12:30</td>
<td>1:20</td>
<td>Koether</td>
</tr>
<tr>
<td>Morton</td>
<td>120</td>
<td>12:30</td>
<td>1:20</td>
<td>Marion</td>
</tr>
<tr>
<td>Morton</td>
<td>112</td>
<td>10:30</td>
<td>11:20</td>
<td>Booker</td>
</tr>
<tr>
<td>Gilmer</td>
<td>025</td>
<td>9:30</td>
<td>10:20</td>
<td>Thurman</td>
</tr>
<tr>
<td>Gilmer</td>
<td>012</td>
<td>9:30</td>
<td>10:20</td>
<td>Bloom</td>
</tr>
</tbody>
</table>

What are the candidate keys?
Example

- The candidate keys are
  - (Bldg, Room, Start)
  - (Bldg, Room, End)
  - (Start, Prof)
  - (End, Prof)

- Verify that this relation is in 3NF.
However, each professor teaches in only one building.

Therefore, Prof $\rightarrow$ Bldg, but Prof is not a superkey.

What to do?
To put the relation in BCNF, create a separate table based on the functional dependency $X \rightarrow A$ that violates BCNF.

In this case, remove (Prof, Bldg) to a separate table.
Outline

1. Third Normal Form
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Assignment

- Read Section 15.5.