Odds and Ends...

- ER diagrams
  - Weak entities
- Relational Schema
  - Make sure you include primary and foreign keys
  - What about chained weak entities?

Relational Algebra

- Renaming
  \[ \rho(R(F), E) = \rho(N(1 \rightarrow SName, 2 \rightarrow SID, 3 \rightarrow DName, A \rightarrow DID), R \times S) \]
  \[ \rho(N(3 \rightarrow DName, 4 \rightarrow DID), R \times S) \]

<table>
<thead>
<tr>
<th>Name</th>
<th>ID</th>
<th>Name</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jean</td>
<td>54321</td>
<td>Marketing</td>
<td>6</td>
</tr>
<tr>
<td>Mike</td>
<td>12405</td>
<td>Research</td>
<td>5</td>
</tr>
</tbody>
</table>
Joins

• Can be derived from cross-product and projection/selection
• More frequent than cross-product in practice

Joins

• Conditional joins
  $R \bowtie c S = \sigma_c (R \times S)$
• Example
  - S1 Sailors(sid:integer, sname:string, rating:integer, age:real)
  - B1 Boats(bid:integer, bname:string, color:string)
  - R1 Reserves(sid:integer, bid:integer, day:date)
  $S_1 \bowtie (S1, sid = R1, sid \rightarrow R_1$}

Joins

• Equijoins
  $R \bowtie c S = \sigma_c (R \times S)$
• Example
  - S1 Sailors(sid:integer, sname:string, rating:integer, age:real)
  - B1 Boats(bid:integer, bname:string, color:string)
  - R1 Reserves(sid:integer, bid:integer, day:date)
  $S_1 \bowtie (S1, sid = R1, sid \rightarrow R_1$}
Joins

- Natural joins
  \[ R \bowtie S = \sigma_c (R \times S) \]
- Example
  - S1: Sailors(sid:integer, sname:string, rating:integer, age:real)
  - B1: Boats(bid:integer, bname:string, color:string)
  - R1: Reserves(sid:integer, bid:integer, day:date)
  \[ S_1 \bowtie R_1 \]
  or
  \[ S_1 \bowtie S \]

Joins

- More examples
  - S1: Sailors(sid:integer, sname:string, rating:integer, age:real)
  - B1: Boats(bid:integer, bname:string, color:string)
  - R1: Reserves(sid:integer, bid:integer, day:date)

- Find the names of sailors who have reserved boat 103

\[ \pi_{\text{name}} ((\sigma_{\text{bid}=103} (R_1)) \bowtie S_1) \]
Joins

- More examples
  - \( S_1 \) Sailors(sid:integer; sname:string; rating:integer; age:real)
  - \( B_1 \) Boats(bid:integer; bname: string; color: string)
  - \( R_1 \) Reserves(sid:integer; bid: integer; day: date)

- Find the names of sailors who have reserved boat 103
  \[
  \pi_{\text{name}} \left( \sigma_{\text{bid}=103} \left( R_1 \times S_1 \right) \right)
  \]

- Find the names of sailors who have reserved a red boat
  \[
  \pi_{\text{name}} \left( \left( \sigma_{\text{color}=\text{red}} \left( R_1 \right) \right) \bowtie R_1 \bowtie S_1 \right)
  \]
Joins

- More examples
  - S1: Sailors(sid: integer, sname: string, rating: integer, age: real)
  - B1: Boats(bid: integer, bname: string, color: string)
  - R1: Reserves(sid: integer, bid: integer, day: date)

- Find the names of sailors who have reserved at least a boat

\[ \pi_{\text{name}}(R_1 \bowtie_{ \geq} S_1) \]

- Find the names of sailors who have reserved a red or green boat
Joins

- More examples
  - S1 Sailors(sid:integer, sname:string, rating:integer, age:real)
  - B1 Boats(bid:integer, bname: string, color: string)
  - R1 Reserves(sid:integer, bid: integer, day: date)

- Find the names of sailors who have reserved a red or green boat
  \[ \rho(\text{Tempboats}, (\sigma_{\text{color}=\text{red}} B_1) \cup (\sigma_{\text{color}=\text{green}} B_1)) \]
  \[ \pi_{\text{sname}}(\text{Tempboats} \bowtie R_1 \bowtie S_1) \]
Joins

- More examples
  - S1: Sailors(sid:integer, sname:string, rating:integer, age:real)
  - B1: Boats(bid:integer, bname: string, color: string)
  - R1: Reserves(sid:integer, bid: integer, day: date)

- Find the names of sailors who have reserved at least two boats

\[
\rho(\text{Reservationpairs}(4 \rightarrow \text{sid}, 5 \rightarrow \text{bid}, 6 \rightarrow \text{day})),
R_1 \times R_2
\]
\[
\pi_{\text{name}}(\sigma_{\text{sid} = \text{sid}})(\text{Reservationpairs} \bowtie S_1)
\]

Division

- Find the sailors who have reserved all the boats

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<tr>
<th>sid</th>
<th>bid</th>
</tr>
</thead>
<tbody>
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<td>2</td>
</tr>
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<td>13</td>
<td>2</td>
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<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

\[
\frac{\begin{bmatrix}
15 & 1 \\
15 & 2 \\
15 & 3 \\
13 & 1 \\
13 & 2 \\
16 & 3
\end{bmatrix}}{\begin{bmatrix}
1 \\
2 \\
3
\end{bmatrix}} = \begin{bmatrix}
15
\end{bmatrix}
\]

Division

- Find the sailors who have reserved all the boats

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<tr>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

\[
\rho(\text{Tempsid}(\sigma_{\text{sid} \neq 15}(R_1))/(\pi_{\text{bid}}(R_2)))
\]
\[
\pi_{\text{name}}(\text{Tempsid} \bowtie S_1)
\]
• Retrieve the name and address of all employees who work for the 'Research' dept.
• Retrieve the names of employees who have no dependents.