Constraint Propagation

• Three sample problems

• An educational application making use of constraints

• Constraints in Ising systems and Cellular Automata
An Example of an Event Constraint System (from Cormen, Leiserson, and Rivest)

Event 1 must occur at least 0 before event 2.
Event 1 must occur at least 1 before event 5.
Event 2 must occur before or at most 1 after event 5.
Event 3 must occur before or at most 5 after event 1.
Event 4 must occur before or at most 4 after event 1.
Event 4 must occur at least 1 before event 3.
Event 5 must occur at least 3 before event 3.
Event 5 must occur at least 3 before event 4.
\( x_1 - x_2 \leq 0 \)
\( x_1 - x_5 \leq -1 \)
\( x_2 - x_5 \leq 1 \)
\( x_3 - x_1 \leq 5 \)
\( x_4 - x_1 \leq 4 \)
\( x_4 - x_3 \leq -1 \)
\( x_5 - x_3 \leq -3 \)
\( x_5 - x_4 \leq -3 \)
<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>-5</td>
</tr>
<tr>
<td>X2</td>
<td>-3</td>
</tr>
<tr>
<td>X3</td>
<td>0</td>
</tr>
<tr>
<td>X4</td>
<td>-1</td>
</tr>
<tr>
<td>X5</td>
<td>-4</td>
</tr>
</tbody>
</table>
Constraint Propagation: Recurring Issues

• Do we want a "solution"?
• Existence (of a solution)
• Uniqueness
• "Hard" vs. "Soft" constraints
• Evolution of networks
• Relaxation as a general strategy