**LOGISTICS DOMAIN**

<table>
<thead>
<tr>
<th>Action</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin(B, C)</td>
<td>unload(b*, t*)</td>
</tr>
<tr>
<td>On(B, T)</td>
<td>load(b*, t*, c*)</td>
</tr>
<tr>
<td>Tin(T, C)</td>
<td>drive(t*, c*)</td>
</tr>
</tbody>
</table>

**DOMAIN DYNAMICS CAPTURED BY TRUTH VALUE DIAGRAM**

First Order Decision Diagrams for Relational MDPs

**REWARD FUNCTION**

\[ V^0(B(b, Paris)) = \begin{cases} 
10 & \text{if } \text{rain} \\
0 & \text{otherwise} 
\end{cases} \]

**VALUE ITERATION ALGORITHM**

\[ T_{n+1}^A(x) (V_n) = \gamma \left[ \sum_{i} \left( \text{prob} \left( A_i \rightarrow x \right) \otimes \text{Regr} \left( V_n, A_i \rightarrow x \right) \right) \right] \]

\[ Q_{n+1}^A = R \oplus \text{obj} - \max \left( T_{n+1}^A(x) (V_n) \right) \]

\[ V_{n+1} = \max (Q_{n+1}^A) \]

Operation implemented by:

- Standardize apart – combine - reduce

**FOOD SEMANTICS**

- Multiple Path semantics
- more suitable for Value Iteration

\[ D = \{ 1, 2 \} \]

\[ I = \{ p(1), q(2), h(2) \} \]

**SINGLE PATH SEMANTICS**

\[ \exists x, p(x) \quad \text{Blockeel & DeRaedt 97} \]

\[ \land \exists z [ p(z) \land q(z)] : 0 \]

\[ \text{MAP}_B(I) = 0 \]

**MULTIPLE PATH SEMANTICS**

\[ \exists x, p(x) \quad \text{Groote & Tv 03} \]

\[ \zeta = \{ x/1, y/1 \} \rightarrow \text{MAP}_B(I, \zeta) = 0 \]

\[ \zeta = \{ x/1, y/2 \} \rightarrow \text{MAP}_B(I, \zeta) = 0 \]

\[ \zeta = \{ x/2, y/1 \} \rightarrow \text{MAP}_B(I, \zeta) = 0 \]

\[ \zeta = \{ x/2, y/2 \} \rightarrow \text{MAP}_B(I, \zeta) = 1 \]

\[ \text{MAP}_B(I) = \max \{ \text{MAP}_B(I, \zeta) \} \]

\[ \text{MAP}_B(I) = 1 \]

**EXPECTED ABSTRACT VALUE FUNCTION OVER STOCHASTIC ACTION unload(b*, t*)**

The diagram gets complicated but it can be reduced using reduction operators. The parts inside the colored contours can be removed. Finally the diagram is reduced to [4] prior to object maximization.

- [4] Object maximization is performed on this reduced diagram.
- The equality node will be eliminated (R6) and its true branch will survive since b* is now a variable and its value can be chosen to make the equality true.

- [5] Maximization over all actions gives \( V^1 \)

- [6] Block replacement for the next iteration. Implemented by block combination using \[ B \times B_i + (1 - B) \times B_i \]