Exercise 10.1 (Merge-and-Shrink abstractions, 2 + 3 points)

Consider the (SAS⁺) Gripper planning task \( \Pi \) from Exercise Sheet 9. The graph for \( T^{\pi_{t=t_1}} \otimes T^{\pi_{t=t_2G_1}} \) and its two-dimensional table are given by

The corresponding one-dimensional tables are given by

\[
\begin{array}{l|c|c}
T_{b_k}^1 & s_2 = 0 & s_2 = 1 \\
\hline
s_1 = 0 & 0 & 1 \\
 s_1 = 1 & 2 & 3 \\
 s_1 = 2 & 4 & 5 \\
 s_1 = 3 & 6 & 7 \\
\end{array}
\]

(a) Shrink the graph by collapsing all nodes with identical \( g \) and \( h \) values. Use linked lists to renumber the nodes. Visualize the resulting graph, and specify the resulting new two-dimensional table and the final status of the linked list.
(b) Which heuristic value do we get for \( s = \{ \text{pos}_{B_1} \mapsto L, \text{pos}_{B_2} \mapsto G_1, \text{pos}_{\text{Robby}} \mapsto R, \text{status}_{G_1} \mapsto F, \text{status}_{G_2} \mapsto E \} \) and how is the look-up of the value performed?

**Exercise 10.2** (Dynamic programming, 3 points)

Consider the propositional nondeterministic planning task \( \Pi' = \langle A', I', O', \gamma' \rangle \), with

- the set of variables \( A' = \{a, b, c\} \),
- initial state \( I' = \{a \mapsto 0, b \mapsto 0, c \mapsto 1\} \),
- set of operators \( O' = \{o_1, o_2, o_3\} \), where
  - \( o_1 = \langle a, \{b \land c, b \land \neg c\} \rangle \),
  - \( o_2 = \langle \neg a \land b, \{a \land \neg b, a\} \rangle \),
  - \( o_3 = \langle \neg b, \{\neg a \land b\} \rangle \)
- and goal \( \gamma' = a \land b \)

Determine a strong plan for \( \Pi' \) by computing backward distances with the dynamic programming algorithm.

**Exercise 10.3** (Symbolic regression search with boolean function operations, 2 points)

Consider the planning task \( \Pi' \) from **Exercise 10.2**. Perform a regression search with boolean function operations and simplify all formulas as much as possible. It is sufficient to calculate \( \text{spreimg}_o(\alpha) \), where \( o \) is the operator from the strong plan of Exercise 10.2 that is applied in a state described by \( \text{spreimg}_o(\alpha) \) and results in a state described by \( \alpha \).

*Note: The exercise sheets may and should be worked on in groups of two students. Please state both names on your solution (this also holds for submissions by e-mail).*