ComS 472
Homework 3

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Oct 12, 2020

- 6.1 -

1) 3 colors for (SA), 2 for (WA), 1 for (NT, Q, NSW, V), 3 for (T) $\Rightarrow$
   $3 * 2 * 1 * 1 * 1 * 1 * 3 = 18$ solutions
2) 4:(SA), 3:(WA), 2:(NT, Q, NSW, V), 4:(T) $\Rightarrow 4 * 3 * 2 * 2 * 2 * 2 * 4 = 768$ solutions
3) 2:(SA), 1:(WA), 0:(NT, Q, NSW, V), 2:(T) $\Rightarrow 2 * 1 * 0 * 0 * 0 * 0 * 2 = 0$ solutions

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- 6.6 -

1) Introduce variable D as a set of pair values (D_1, D_2). $A = D_1, B = D_2, and\ C = D_1 + D_2$

2) Constraints with more than 3 variables can be reduced in tiers, with n-1 variables reduced to n, n to n-1, ..., continuing until the set of constraints contains only binary constraints.

3) Unary constraints can be completely eliminated by moving the effects of the constraint into the domain of the variable it is affecting.

- 6.8 -

1) A1 $\rightarrow$ R ✓
2) H $\rightarrow$ R **X**, conflicts with A1 $\rightarrow$ backtrack
3) H $\rightarrow$ G ✓
4) A4 $\rightarrow$ R ✓
5) F1 $\rightarrow$ R ✓
6) A2 $\rightarrow$ R ✓
7) F2 $\rightarrow$ R ✓
8) A3 $\rightarrow$ R ✓
9) T $\rightarrow$ R **X**, conflicts with F1 $\rightarrow$ backtrack
9) T $\rightarrow$ G **X**, conflicts with H $\rightarrow$ backtrack
9) T $\rightarrow$ B ✓

- 6.11 -

Arcs:
$(SA \neq WA), (WA \neq SA), (SA \neq NT), (NT \neq SA), (SA \neq Q), (Q \neq SA),$
$(SA \neq NSW), (NSW \neq SA), (SA \neq V), (V \neq SA), (WA \neq NT), (NT \neq WA),$
$(NT \neq Q), (Q \neq NT), (Q \neq NSW), (NSW \neq Q), (NSW \neq V), (V \neq NSW)$

Initial Constraints:
SA={RGB}, WA={RGB}, NT={RGB}, Q={RGB}, NSW={RGB}, V={RGB}, T={RGB}

Set WA=green, V=red...

1)

C: SA={RGB}, WA={_G_}, NT={RGB}, Q={RGB}, NSW={RGB}, V={R__}, T={RGB}
A: All arcs, $(SA \neq WA), (NT \neq WA), (SA \neq V), (NSW \neq V)$ at the end for conciseness.
Action: Check and dequeue all consistent arcs.

2)

C: SA={RGB}, WA={_G_}, NT={RGB}, Q={RGB}, NSW={RGB}, V={R__}, T={RGB}
A: $(SA \neq WA), (NT \neq WA), (SA \neq V), (NSW \neq V)$
Action: $(SA \neq WA)$ is inconsistent. Remove G from SA, queue arcs with SA on right.

3)

C: SA={R_B}, WA={_G_}, NT={RGB}, Q={RGB}, NSW={RGB}, V={R__}, T={RGB}
A: $(NT \neq WA), (SA \neq V), (NSW \neq V), (WA \neq SA), (NT \neq SA), (Q \neq SA),$
$(NSW \neq SA), (V \neq SA)$
Action: $(NT \neq WA)$ is inconsistent. Remove G from NT, queue arcs with NT on right.

4)

C: SA={R_B}, WA={_G_}, NT={R_B}, Q={RGB}, NSW={RGB}, V={R__}, T={RGB}
A: $(SA \neq V), (NSW \neq V), (WA \neq SA), (NT \neq SA), (Q \neq SA), (NSW \neq SA),$
$(V \neq SA), (WA \neq NT), (Q \neq NT)$
Action: $(SA \neq V)$ is inconsistent. Remove R from SA, queue arcs with SA on right.

5)

C: SA={__B}, WA={_G_}, NT={R_B}, Q={RGB}, NSW={RGB}, V={R__}, T={RGB}
A: $(NSW \neq V), (WA \neq SA), (NT \neq SA), (Q \neq SA), (NSW \neq SA), (V \neq SA),$
$(WA \neq NT), (Q \neq NT)$
Action: $(NSW \neq V)$ is inconsistent. Remove R from NSW, queue arcs with NSW on right.

6)

C: SA={__B}, WA={_G_}, NT={R_B}, Q={RGB}, NSW={_GB}, V={R__}, T={RGB}
A: $(WA \neq SA), (NT \neq SA), (Q \neq SA), (NSW \neq SA), (V \neq SA), (WA \neq NT),$
$(Q \neq NT), (SA \neq NSW), (Q \neq NSW), (V \neq NSW)$
Action: $(WA \neq SA)$ is consistent. Dequeue.

7)

C: SA={__B}, WA={_G_}, NT={R_B}, Q={RGB}, NSW={_GB}, V={R__}, T={RGB}
A: $(NT \neq SA), (Q \neq SA), (NSW \neq SA), (V \neq SA), (WA \neq NT), (Q \neq NT),$
$(SA \neq NSW), (Q \neq NSW), (V \neq NSW)$
Action: $(NT \neq SA)$ is inconsistent. Remove B from NT, queue arcs with NT on right.

8)

C: SA={__B}, WA={_G_}, NT={R__}, Q={RGB}, NSW={_GB}, V={R__}, T={RGB}
A: $(Q \neq SA), (NSW \neq SA), (V \neq SA), (WA \neq NT), (Q \neq NT), (SA \neq NSW),$
$(Q \neq NSW), (V \neq NSW), (SA \neq NT)$
Action: $(Q \neq SA)$ is inconsistent. Remove B from Q, queue arcs with Q on right.

9)

C: SA={__B}, WA={_G_}, NT={R__}, Q={RG_}, NSW={_GB}, V={R__}, T={RGB}
A: $(NSW \neq SA), (V \neq SA), (WA \neq NT), (Q \neq NT), (SA \neq NSW), (Q \neq NSW),$
$(V \neq NSW), (SA \neq NT), (SA \neq Q), (NT \neq Q), (NSW \neq Q)$
Action: $(NSW \neq SA)$ is inconsistent. Remove B from NSW, queue arcs with NSW on right.

10)

C: SA={__B}, WA={_G_}, NT={R__}, Q={RG_}, NSW={_GB}, V={R__}, T={RGB}
A: $(V \neq SA), (WA \neq NT), (Q \neq NT), (SA \neq NSW), (Q \neq NSW), (V \neq NSW),$
$(SA \neq NT), (SA \neq Q), (NT \neq Q), (NSW \neq Q)$
Action: $(V \neq SA)$ is consistent. Dequeue.

11)

C: SA={__B}, WA={_G_}, NT={R__}, Q={RG_}, NSW={_GB}, V={R__}, T={RGB}
A: $(WA \neq NT), (Q \neq NT), (SA \neq NSW), (Q \neq NSW), (V \neq NSW), (SA \neq NT),$
$(SA \neq Q), (NT \neq Q), (NSW \neq Q)$
Action: $(WA \neq NT)$ is consistent. Dequeue.

12)

C: SA={__B}, WA={_G_}, NT={R__}, Q={RG_}, NSW={_GB}, V={R__}, T={RGB}
A: $(Q \neq NT), (SA \neq NSW), (Q \neq NSW), (V \neq NSW), (SA \neq NT), (SA \neq Q),$
$(NT \neq Q), (NSW \neq Q)$
Action: $(Q \neq NT)$ is inconsistent. Remove R from Q, queue arcs with Q on right.

13)

C: SA={__B}, WA={_G_}, NT={R__}, Q={_G_}, NSW={_GB}, V={R__}, T={RGB}
A: $(SA \neq NSW), (Q \neq NSW), (V \neq NSW), (SA \neq NT), (SA \neq Q), (NT \neq Q),$
$(NSW \neq Q)$
Action: $(SA \neq NSW)$ is inconsistent. Remove B from SA, queue arcs with SA on right.

This leaves SA with no possible values, revealing an inconsistency in the partial assignment.

- 6.20 -

Variables: $S_1, S_2, ..., S_n$
Domain: Set of adjacent square pairs a domino can cover (s_1, s_2).
Constraints: No two dominos can cover the same square.

Variables: $D_1, D_2, ..., D_n$
Domain: Set of pairs (s, s'), with s = current square and s' = one of 4 adjacent squares.
Constraints: A square must only link to one other square. Square A can link to square B if square B can link to A.

A tree-structured constraint graph can be accomplished with a straight line of 6 squares.

A tree-structured graph requires there to be no loops. If the layout of the squares has no cycles, the resulting constraint graph will be tree-structured.

- 7.4 -

1) Correct: Because false will never be true, it doesn't matter what the second half of the equation is.
2) Incorrect: True is always true, but False will never be true, so by definition it is incorrect.
3)

- 7.6 -

- 7.7 -

- 7.15 -

- 7.16 -