第三次作业答案

6.5 分别用带有前向检验、MRV和最少约束值启发式的回溯算法手工求解**图6.2**中的密码算数问题

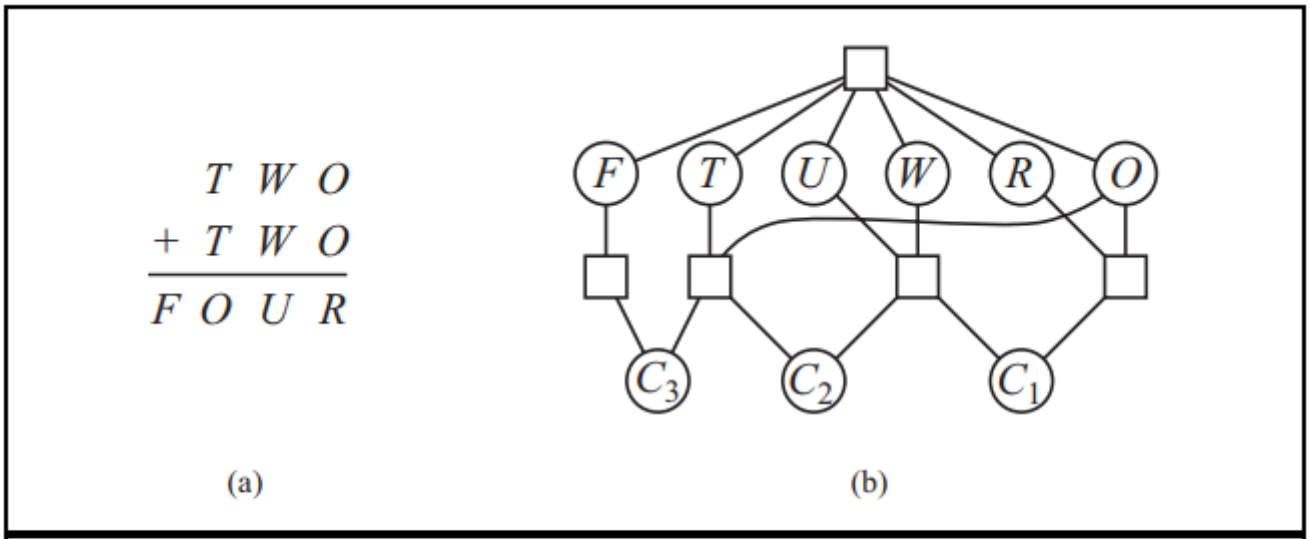

Figure 6.2 (a) A cryptarithmetic problem. Each letter stands for a distinct digit; the aim is to find a substitution of digits for letters such that the resulting sum is arithmetically correct, with the added restriction that no leading zeroes are allowed. (b) The constraint hypergraph for the cryptarithmetic problem, showing the *Alldiff* constraint (square box at the top) as well as the column addition constraints (four square boxes in the middle). The variables C_1, C_2, and C_3 represent the carry digits for the three columns.

a. Choose the X_3 variable. Its domain is $\{0, 1\}$.

b. Choose the value 1 for X_3. (We can't choose 0; it wouldn't survive forward checking, because it would force F to be 0, and the leading digit of the sum must be non-zero.)

c. Choose F, because it has only one remaining value.

d. Choose the value 1 for F.

e. Now X_2 and $\mathbf{X}_1$ are tied for minimum remaining values at 2; let's choose X_2.

f. Either value survives forward checking, let's choose 0 for X_2.

g. Now X_1 has the minimum remaining values.

h. Again, arbitrarily choose 0 for the value of X_1.

i. The variable O must be an even number (because it is the sum of $T + T$ less than 5 (because $O + O = R + 10 \times 0$). That makes it most constrained.

j. Arbitrarily choose 4 as the value of O.

k. R now has only 1 remaining value.

l. Choose the value 8 for R.

m. T now has only 1 remaining value.

n. Choose the value 7 for T.
o. U must be an even number less than 9; choose U.
p. The only value for U that survives forward checking is 6.
q. The only variable left is W.
r. The only value left for W is 3.
s. This is a solution.

6.11 用**AC-3**算法说明弧相容对**图6.1**中问题能够检测出部分赋值，$WA = green, V = red$ 的不相容。

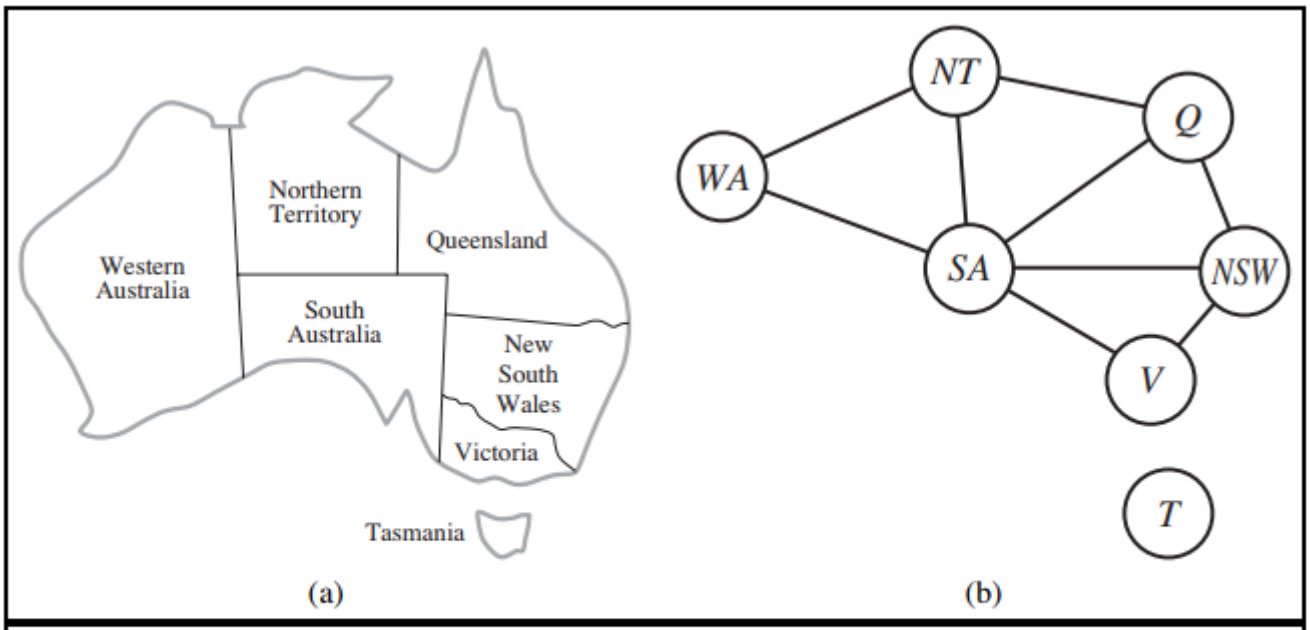

Figure 6.1 (a) The principal states and territories of Australia. Coloring this map can be viewed as a constraint satisfaction problem (CSP). The goal is to assign colors to each region so that no neighboring regions have the same color. (b) The map-coloring problem represented as a constraint graph.

a. Remove $SA - WA$, delete G from SA.
b. Remove $SA - V$, delete R from SA, leaving only B.
c. Remove $NT - WA$, delete G from NT.
d. Remove $NT - SA$, delete B from NT, leaving only R.
e. Remove $NSW - SA$, delete B from NSW.
f. Remove $NSW - V$, delete R from NSW, leaving only G.
g. Remove $Q - NT$, delete R from Q.
h. Remove $Q - SA$, delete B from Q.
i. remove $Q - NSW$, delete G from Q, leaving no domain for Q.

6.12 用**AC-3**算法求解树结构**CSP**在最坏情况下的复杂度是多少?

- 采用逆拓扑序检验，保证每条弧只需要检验一次
- 假设每个顶点的值域最多有 d 个取值，则每条弧检验复杂度为 $O(d^2)$
- 假设有 n 个顶点，则用**AC-3**算法在最坏情况下的复杂度是 $O(nd^2)$