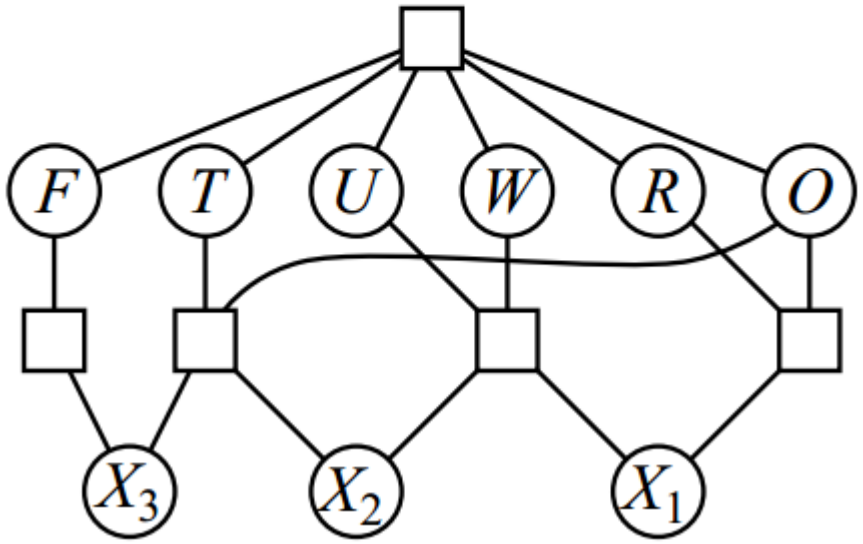
BLG435E
Artificial Intelligence

Practice Session 2: CSP

CSP 1

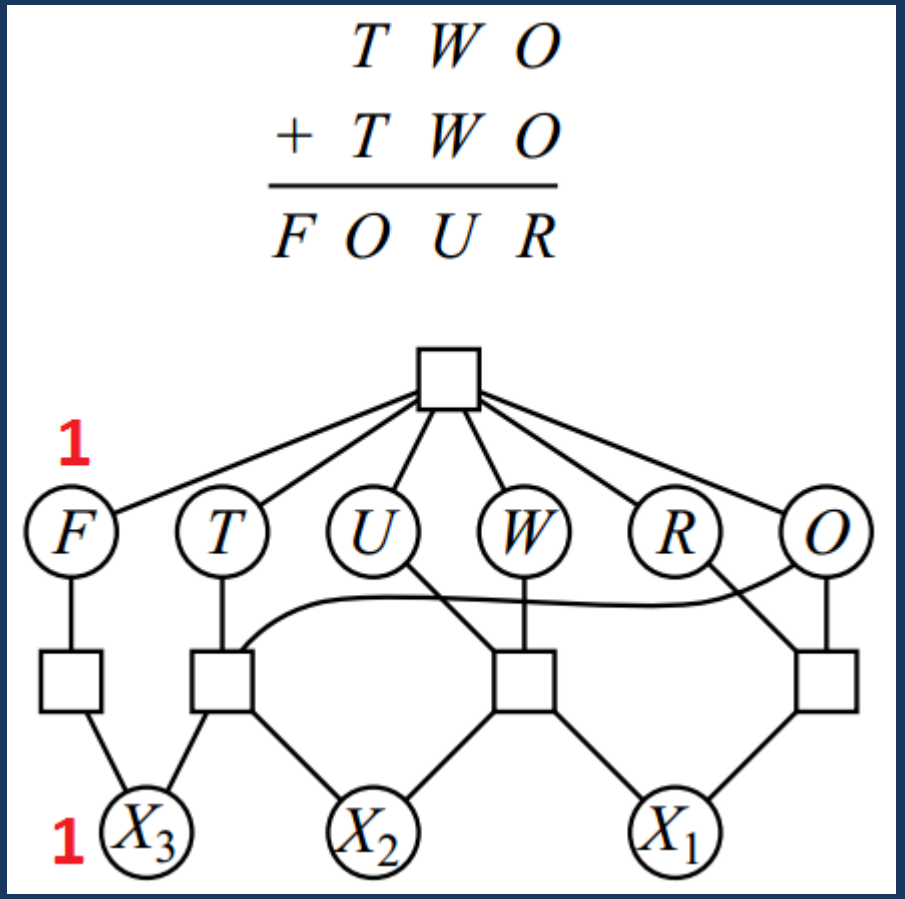
- Solve the cryptarithmetic problem, using backtracking, forward checking, and the MRV and least-constraining-value heuristics.
- In this problem, the aim is to find a substitution of digits for letters such that the resulting sum is correct
  - where each letter stands for a distinct digit and
  - no leading zeroes are allowed

$$\begin{array}{r} T\ W\ O \\ +\ T\ W\ O \\ \hline F\ O\ U\ R \end{array}$$



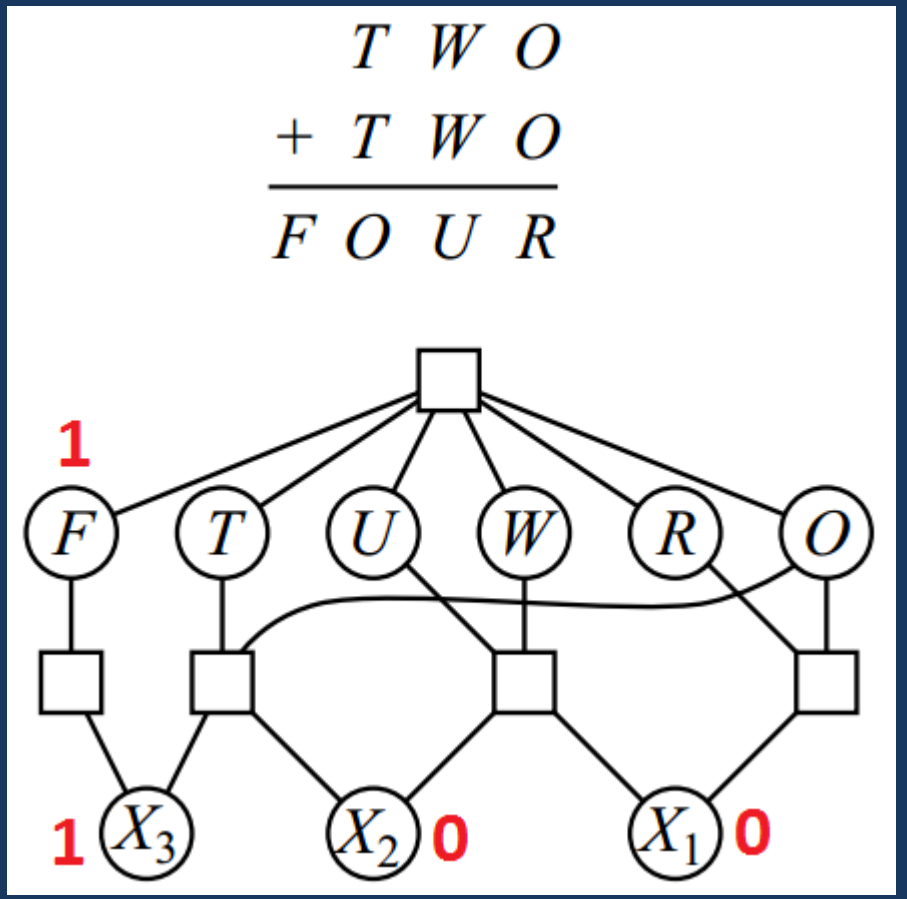
CSP 1

- The exact steps depend on certain choices you are free to make:
  a) Choose the **X3** variable. Its domain is {0, 1}.
  b) Choose the value 1 for **X3**. (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**.



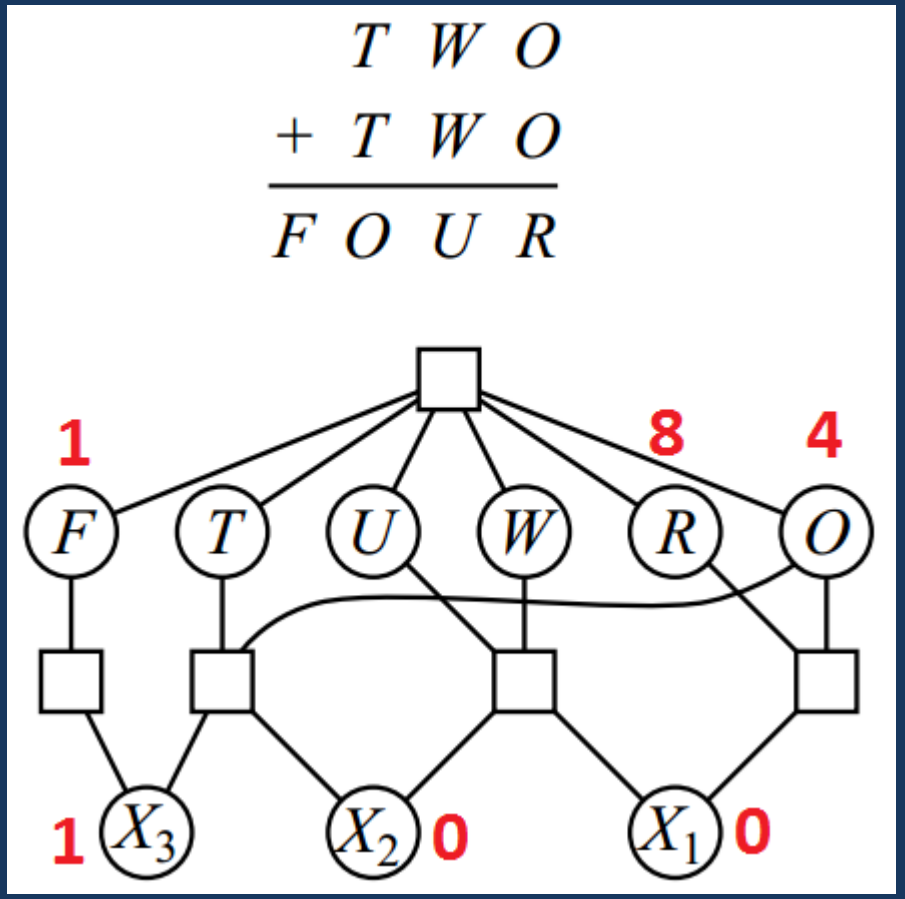
CSP 1

- The exact steps depend on certain choices you are free to make:
  e) Now **X2** and **X1** are tied for minimum remaining values at 2; let's choose **X2**.
  f) Either value survives forward checking, let's choose 0 for **X2**.
  g) Now **X1** has the minimum remaining values.
  h) Again, arbitrarily choose 0 for the value of **X1**.



CSP 1

- The exact steps depend on certain choices you are free to make:
  - 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 x 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**.



CSP 1

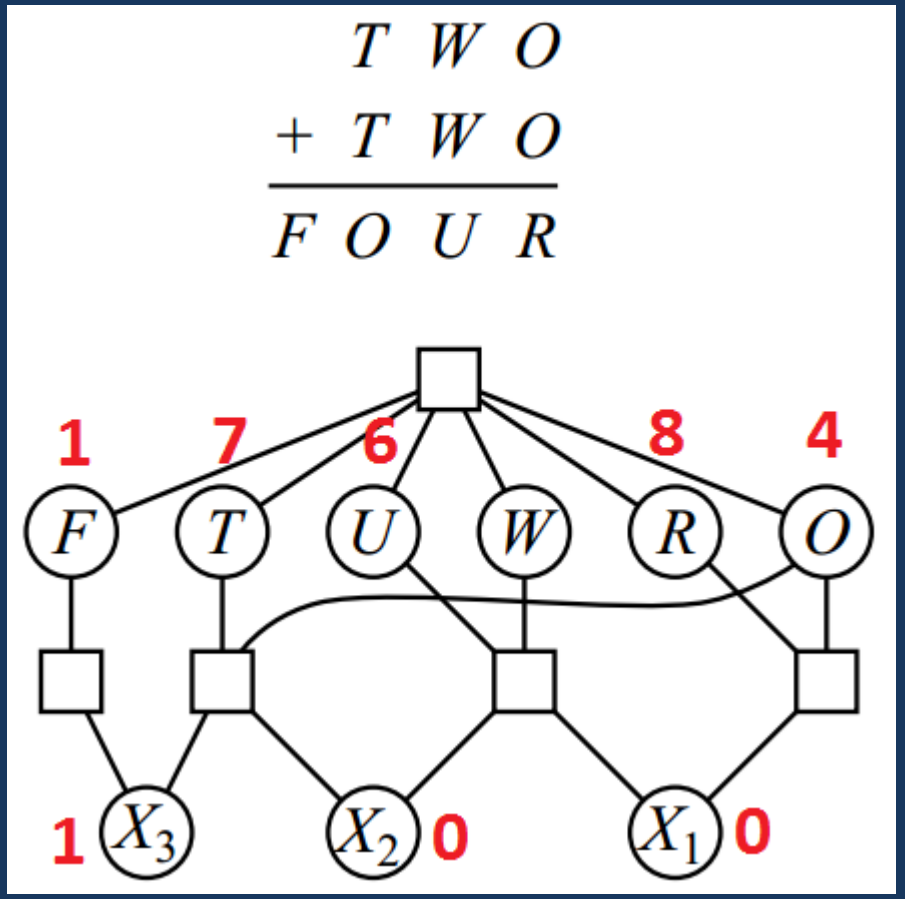
- The exact steps depend on certain choices you are free to make:

m) **T** now has only 1 remaining value.

n) Choose the value 7 for **T**.

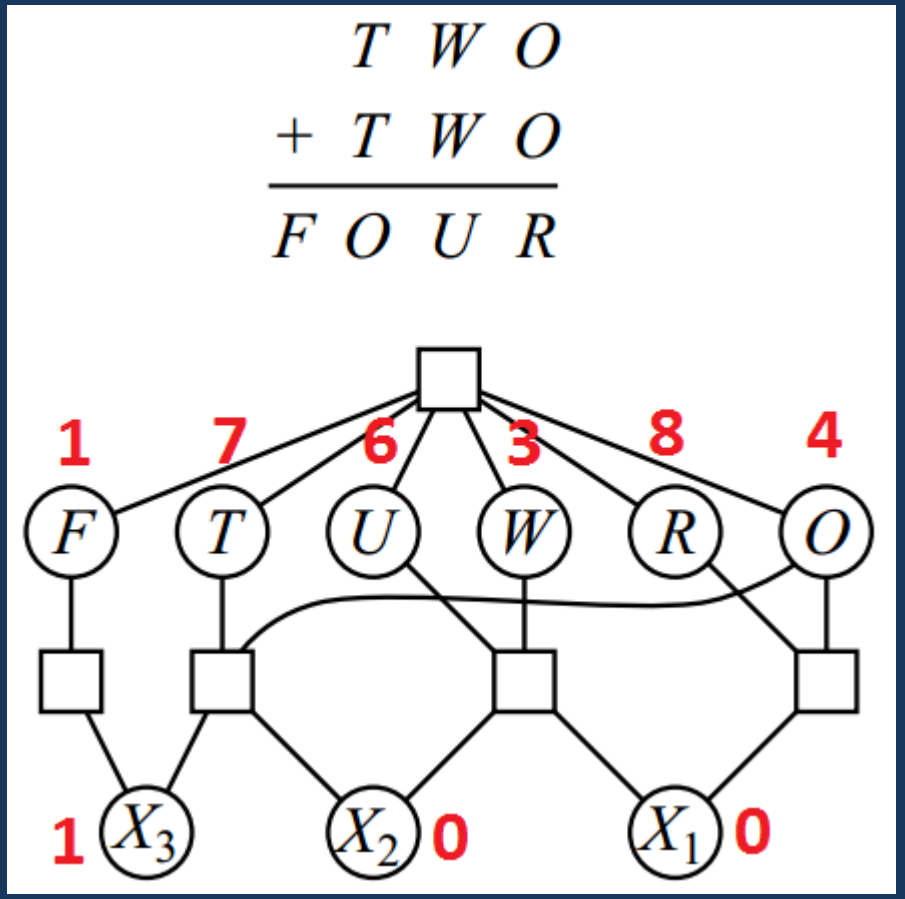
o) **U** must be an even number less than 9; choose **U**.

p) The only value for **U** that survives forward checking is 6



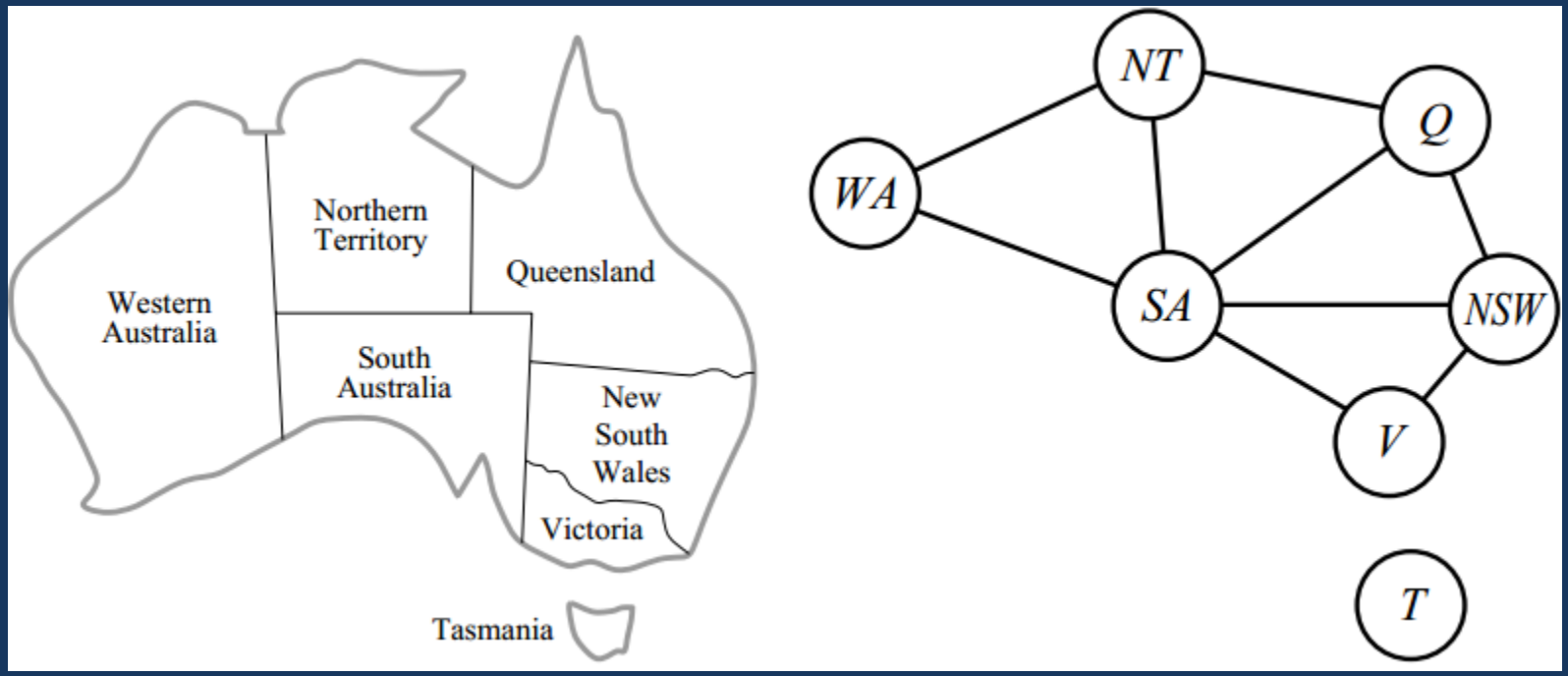
CSP 1

- The exact steps depend on certain choices you are free to make:
  - q) The only variable left is **W**.
  - r) The only value left for **W** is 3.
  - s) This is a solution.



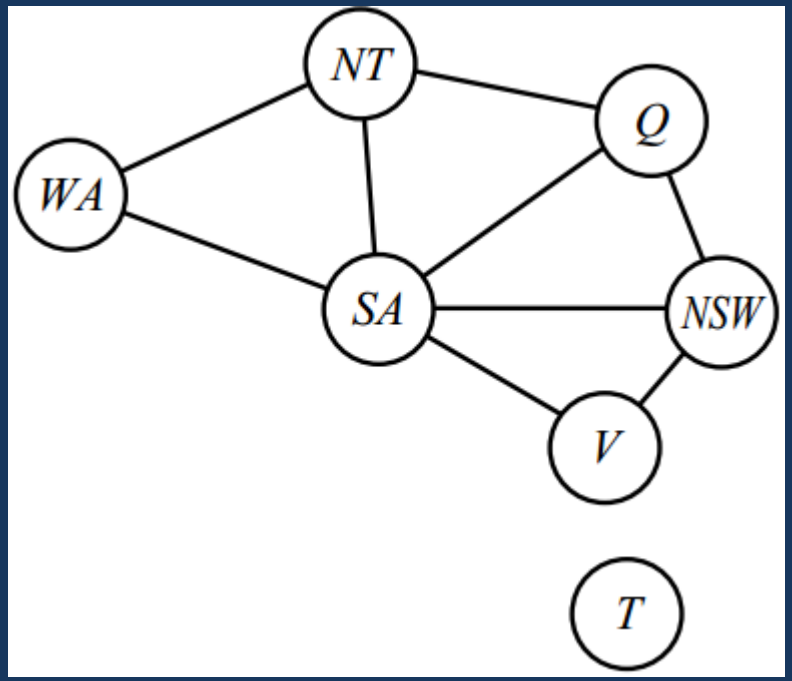
CSP 2

- Use the AC-3 algorithm to show that arc consistency is able to detect the inconsistency of the partial assignment {**WA** = red, **V** = blue} for the problem shown on the right where the goal is to assign colors to each region so that no neighboring regions have the same color.



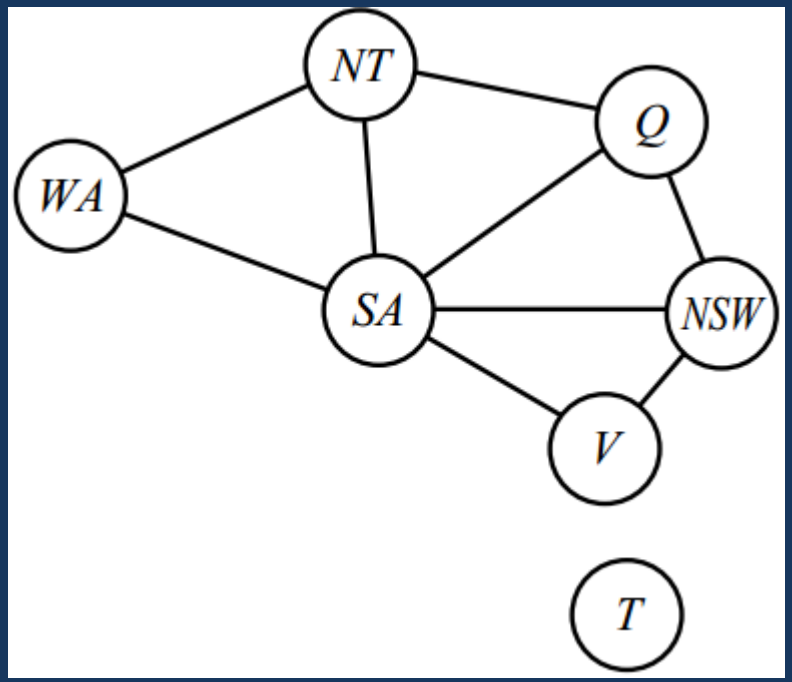
CSP 2

- Remove SA−WA, delete R from SA because there is no value from the domain of WA being consistent with SA = R. Insert NT−SA, Q−SA, NSW−SA, V−SA into the queue (other neighbours of SA).



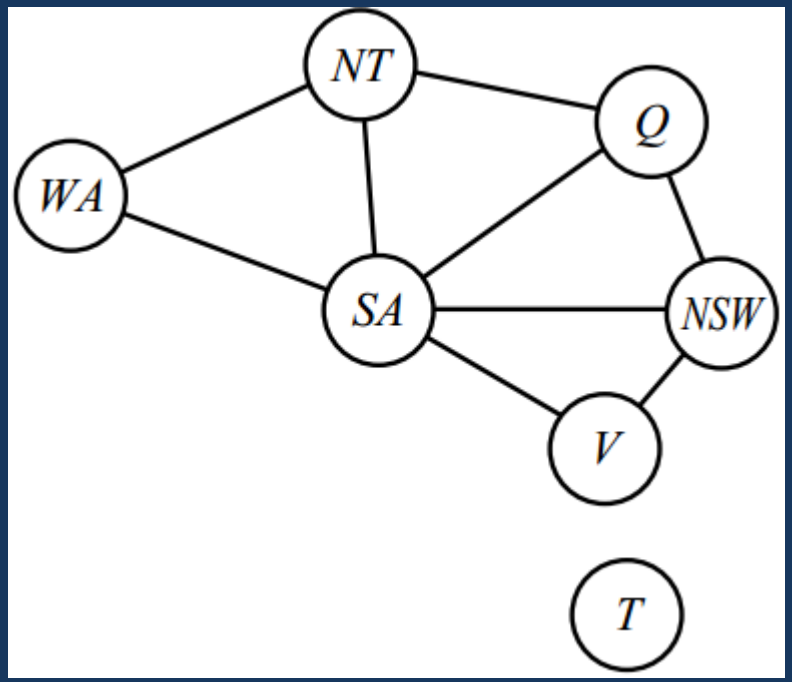
CSP 2

- Remove SA–V, delete B from SA, leaving only G. (For following processes, we will skip the inserting part.)



CSP 2

- Remove NT−WA, delete R from NT.

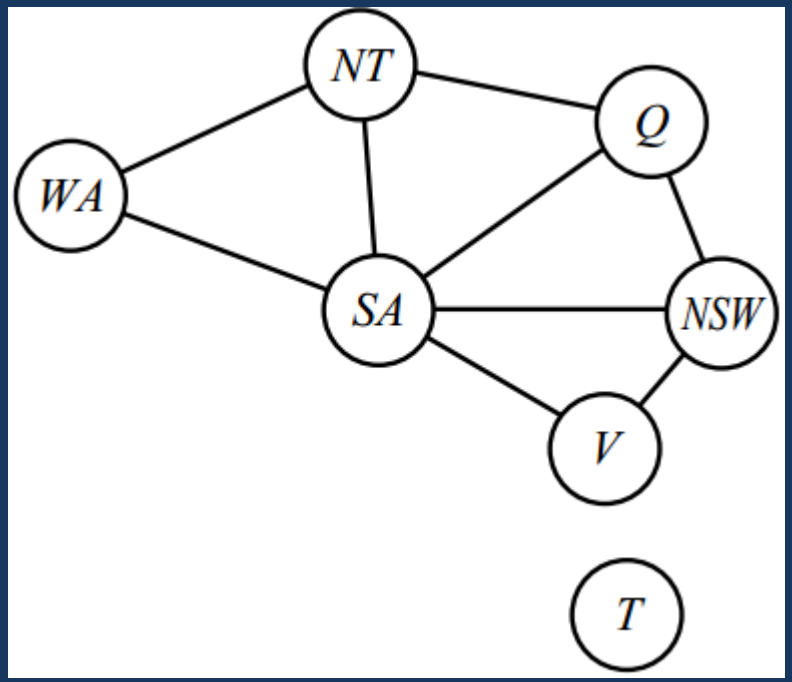


WA	NT	Q	NSW	V	SA	T

WA	NT	Q	NSW	V	SA	T

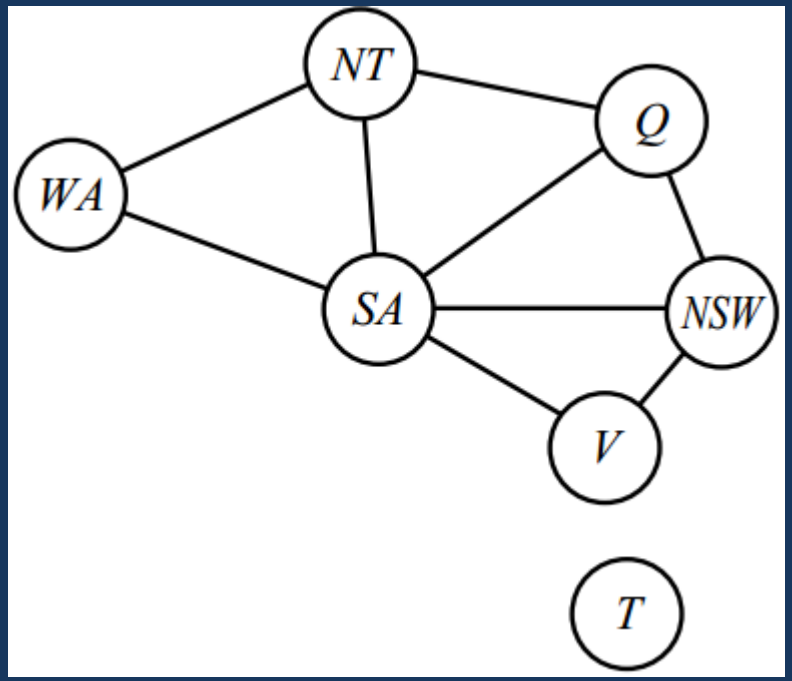
CSP 2

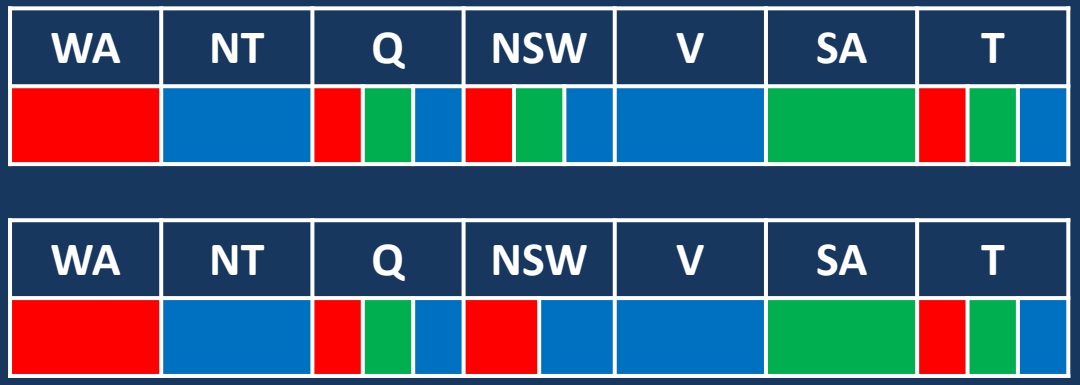
- Remove NT–SA, delete G from NT, leaving only B.



CSP 2

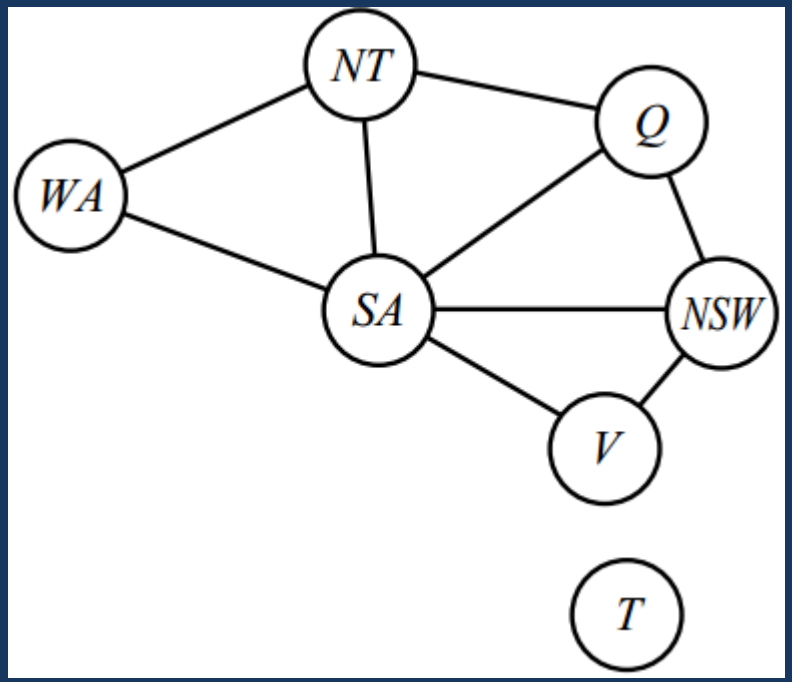
- Remove NSW–SA, delete G from NSW.





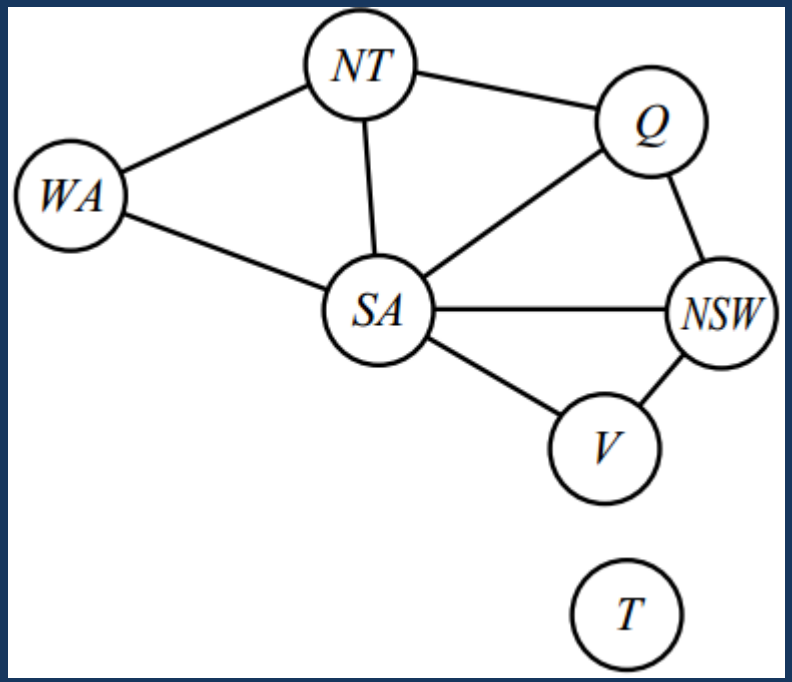
CSP 2

- Remove NSW−V, delete B from NSW, leaving only R.



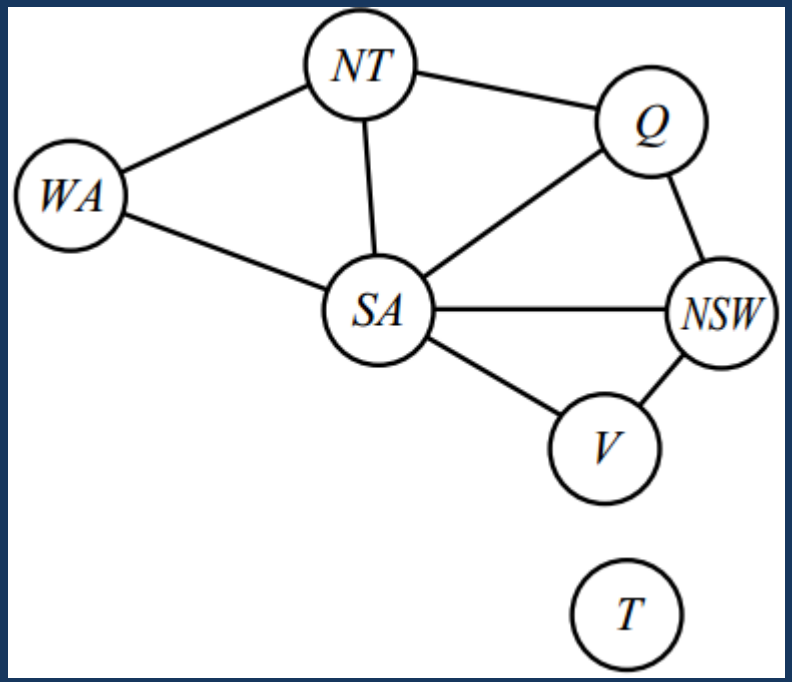
CSP 2

- Remove Q–NT, delete B from Q.



CSP 2

- Remove Q–SA, delete G from Q.

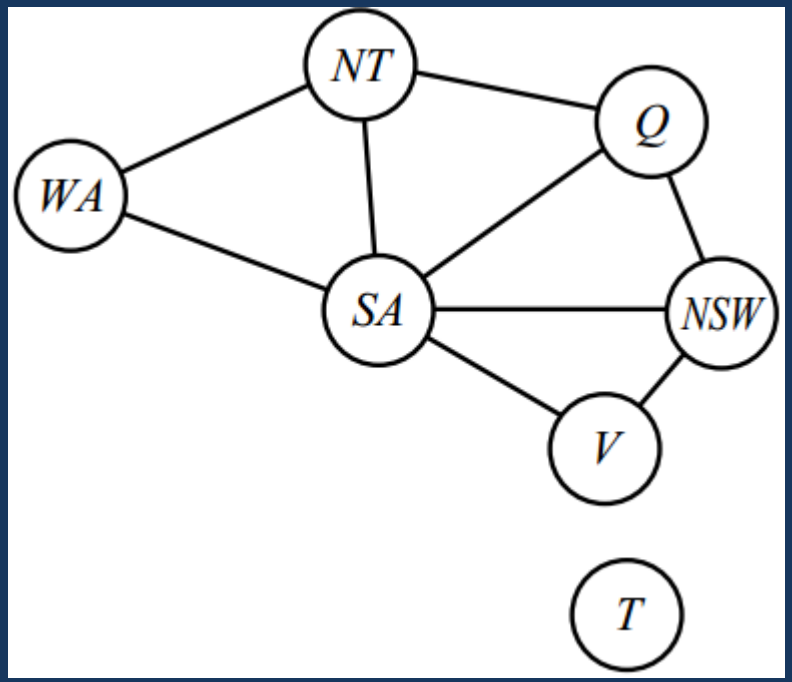


WA	NT	Q	NSW	V	SA	T

WA	NT	Q	NSW	V	SA	T

CSP 2

- Remove Q–NSW, delete R from Q, leaving no domain for Q.



WA	NT	Q	NSW	V	SA	T

WA	NT	Q	NSW	V	SA	T