Problem 5.2 CSP as a Search Problem

Answer:

According to the problem description, a binary CSP P with,

- Set of variables, V
- Domains, $D \coloneqq \{D_v | v \in V\}$
- Constrains, $C \coloneqq \{C_{uv} \subseteq D_u \times D_v | u, v \in V \; and \; u \neq v\}$, where C_{uv} is the dual of C_{vu}

Therefore,

- Constraint network, $\gamma \coloneqq \langle V, D, C \rangle$
- Variable assignment $a: V \rightharpoonup \cup_{u \in V} D_u$, if $a(v) \in D_v$ for all $v \in dom(V)$

The search problem (S, A, T, I, G) corresponding to P is defined below:

- **States:** For CSP P state are variable assignments. Therefore, states set,

  $S = \{a | \; a: V \rightharpoonup \cup_{u \in V} D_u\} \; if \; a(v) \in D_v \; for \; all \; v \in dom(V)$
- **Initial State:** Initial state is empty assignment $\emptyset$. So, $I = S_0 = \emptyset$
- **Goal State:** Goal state means the solution of CSP which is a consistent total assignment. So,

  $G = S_g = a, iff \; \forall C_{uv} \in C, \big(a(u), a(v)\big) \in C_{uv}$
- **Actions:** Action will be the extension of current assignment a_c, let's say extension of a_c is a_e, So,

  $A = \{a_e\} \; where \; dom(a_c) \subset dom(a_e) \; and \; a_e|_{dom(a_c)} = a_c$
- **Transition model:** For CSP, Transition model T will be the next successful assignment via backtracking.