Assignment6 – Constraint Satisfaction

Given: Nov. 29 Due: Dec. 4

Problem 6.1 (Scheduling CS Classes as a CSP)

You are in charge of scheduling for computer science classes that meet Mondays, Wednesdays and Fridays. There are 5 classes that meet on these days and 3 professors who will be teaching these classes. You are constrained by the fact that each professor can only teach one class at a time. The classes are:

- Class 1 - *Intro to Artificial Intelligence*: meets 8:30-9:30am,
- Class 2 - *Intro to Programming*: meets 8:00-9:00am,
- Class 3 - *Natural Language Processing*: meets 9:00-10:00am,
- Class 4 - *Machine Learning*: meets 9:30-10:30am,
- Class 5 - *Computer Vision*: meets 9:00-10:00am.

The professors are:

- Professor A, who is available to teach Classes 1, 2, 3, 4, 5.
- Professor B, who is available to teach Classes 3 and 4.
- Professor C, who is available to teach Classes 2, 3, 4, and 5.

1. Formulate this problem as a *constraint network* in which there is one *variable* per class, stating the *domains*, and *constraints*. *Constraints* should be specified formally and precisely, but may be implicit rather than explicit.
2. Give the *constraint graph* associated with your *constraint network*.
3. Give examples of
   - a *total inconsistent variable assignment*
   - a *solution*

Problem 6.2 (CSP as a Search Problem)

We consider a *constraint network* $P := \langle V, D, C\rangle$ with

- a set V of variables
- a family D of domains D_v for $v \in V$
- a family C of *constraints* $C_{uv} \subseteq D_u \times D_v$ for $u, v \in V$, $u \neq v$ where C_{uv} is the dual of C_{vu}

Define the *search problem* $\langle \mathcal{S}, \mathcal{A}, \mathcal{T}, \mathcal{I}, \mathcal{G} \rangle$ corresponding to P.

Problem 6.3 (Basic Definitions)

Consider the following *constraint network* $\langle V, D, C \rangle$

- $V = \{a, b, c, d\}$
- $D_a = \texttt{bool}$, $D_b = D_c = \{0, 1, 2, 3\}$, $D_d = \{0, 1, 2, 3, 4, 5, 6\}$
- *Constraints* C:
  - if a, then $b \leq 2$
  - if $c < 2$, then a
  - $b + c < 4$
  - $b > d$
  - $d = 2c$

1. Give all *solutions*.
2. Give an *inconsistent total variable assignment*.
3. Give all *consistent* partial assignments α such that $\mathrm{dom}(\alpha) \subseteq \{a, b\}$.

Problem 6.4 (Constraint Network Formalization)

Consider the following *constraint network*$\Pi := \langle V, D, C \rangle$:

- *Variables* $V = \{x, y, z\}$
- *Domains* D: $D_x = \{0, 1, 2\}$, $D_y = \{1, 2\}$, and $D_z = \{0, 1\}$
- *Constraints* C: $x \neq y$, $y > z$

1. Give all *pairs* (v, w) of *variables* such that v is *arc-consistent relative to* w.
2. Give all *solutions* that would remain if we added the *constraint* $x \neq z$ to Π
3. Without using that additional constraint, now assume we assign $y = 1$ in Π and apply forward-checking. Give the resulting domains D_x, D_y, D_z.