Artificial Intelligence 1
Assignment6: Constraint Propagation
– Given Dec. 1, Due Dec. 11 –

Problem 6.1 (Scheduling CS Classes as a CSP) 40 pt

You are in charge of scheduling for computer science classes. There are 5 classes and 3 professors to teach them. 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 binary CSP problem in which there is one variable per class, stating the domains, and constraints. Constraints should be specified formally and precisely.
2. Give the constraint graph associated with your CSP.
3. Give examples of
    - a total inconsistent assignment
    - a solution

Solution:

1.

Variables	Domains
C_1	A
C_2	A,C
C_3	A,B,C
C_4	A,B,C
C_5	A,C

Constraints: $C_1 \neq C_2, C_1 \neq C_3, C_1 \neq C_5, C_3 \neq C_4, C_3 \neq C_5, C_4 \neq C_5$

2.

```
C2
|
C1 — C3
 \  /  \
  C5 — C4
```

3. Various options.

Problem 6.2 (Scheduling CS Classes with Constraint Propagation) 30 pt

Consider the CSP problem for scheduling CS classes from the previous assignment.

1. Show the CSP obtained by running arc-consistency. As usual, you can visualize this as a graph whose
   - nodes are labeled with the variable names and domains
   - edges are labeled with the constraints.
2. Give all optimal cutsets for the CSP.

Solution:

1.

Variable	Domain
C_1	A
C_2	C
C_3	B
C_4	A
C_5	C

2. The two optimal cutsets are $\{C_3\}$ and $\{C_5\}$.

Problem 6.3 (CSP Formalization) 30 pt

Consider the following binary CSP $\Pi := (V, D, C)$:

- Variables $V = \{x, y, z\}$
- Domains D: $D_x = \{0, 1, 2\}$, $D_y = \{1, 2\}$, $D_z = \{0, 1\}$
- 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. Assume we assign $y = 1$ in Π and apply forward-checking. Give the resulting domains D_x, D_y, D_z.

Solution:

- (x, y), (x, z), (y, x), (y, z), (z, x), (z, y)
- Solutions (x, y, z) are $(0, 2, 1)$, $(1, 2, 0)$, $(2, 1, 0)$
- $D_x = \{0, 2\}$, $D_y = \{1\}$, $D_z = \{0\}$
