Basic CSP Formulation Tasks

Each task below should be approached as:

🎯 Define the CSP by identifying:

Variables

Domains

Constraints (mention type: unary, binary, higher-order)

**Task 1: Map Coloring (3-region map)**

**Problem:**

You have 3 countries: A, B, and C.

A borders B and C

B and C do not border each other

You must color the map using 3 colors (Red, Green, Blue), with no two adjacent regions having the same color.

What to do:

List variables

Assign domain

Define constraints (binary)

* **1. Variables:**
* Let the variables represent the regions (countries):
* AAA
* BBB
* CCC

**2. Domains:**

Domain={Red,Green,Blue}

* So:
* A∈{R,G,B}A \in \{R, G, B\}A∈{R,G,B}
* B∈{R,G,B}B \in \{R, G, B\}B∈{R,G,B}
* C∈{R,G,B}C \in \{R, G, B\}C∈{R,G,B}
* **3. Constraints (Binary):**
* We are told:
* A borders B → A≠BA
* A borders C → A≠CA
* B and C **do not** border each other → **no constraint** between BBB and CCC
* So the binary constraints are:
* A≠BA \neq BA=B
* A≠CA \neq CA=C

**Task 2: Simple Sudoku (2x2 mini-grid)**

Problem:

You are given a 2x2 Sudoku grid with 4 cells: A1, A2, B1, B2.

Each must contain a digit from 1 to 2

No digit repeats in any row or column

What to do:

Define the variables

What is the domain of each cell?

Write all constraints (all-diff style)

Constraints are each cell must contain

* **Variable**=A1,A2,B1,B2

**Domain = {1, 2}**

So:

* A1∈{1,2}A1 \in \{1, 2\}A1∈{1,2}
* A2∈{1,2}A2 \in \{1, 2\}A2∈{1,2}
* B1∈{1,2}B1 \in \{1, 2\}B1∈{1,2}
* B2∈{1,2}B2 \in \{1, 2\}B2∈{1,2}

|  |  |
| --- | --- |
| * **Constraints** |  |

|  |  |
| --- | --- |
| • A1 ≠ A2 |  |

|  |  |
| --- | --- |
| • B1 ≠ B2 |  |

|  |  |
| --- | --- |
| • A1 ≠ B1 |  |

|  |
| --- |
| • A2 ≠ B2 |

**Task 3: Exam Scheduling**

Problem:

You must schedule exams for 3 subjects: Math, English, and Science.

Each exam must be scheduled in one of 2 time slots: Morning, Afternoon

The same teacher teaches Math and Science, so those exams cannot be at the same time

What to do:

Variables = subjects

Domains = time slots

Constraint = binary (Math ≠ Science)

* **Variable**=Math,English,Science
* **Domain**=Moening,Afternoon
* **Constraint**= Math ≠ Science

**Task 4: Cryptarithmetic Puzzle (SEND + MORE = MONEY)**

Problem:

In the puzzle SEND + MORE = MONEY, each letter stands for a unique digit from 0–9.

No leading digit (S or M) can be 0.

What to do:

Identify all letter variables

State domain for each

Define constraints:

AllDiff

Arithmetic equation holds

|  |  |
| --- | --- |
| **Variables=** S, E, N, D, M, O, R, Y |  |
| **Domain**={0, 1, 2, 3, 4, 5, 6, 7, 8, 9} |  |
| **Constraints** |  |
| • AllDiff(S, E, N, D, M, O, R, Y) |  |
| • Arithmetic: SEND + MORE = MONEY |  |
| • S ≠ 0, M ≠ 0 |  |