CS404 Assignment 2: Solving Hashi Puzzle as a CSP

Ayca Elif Aktas (27802)
Pelinsu Saraç (28820)

1 Introduction

The Hashi puzzle is a logic puzzle that involves connecting a series of islands using bridges according to specific rules. The objective of the Hashi puzzle is to form a continuous path that connects all islands while satisfying the constraints provided by the numbers on the islands.In this report we present a formulation of the Hashi puzzle as a Constraint Satisfaction Problem (CSP).

2 CSP Formulation

2.1 Variables

The primary variables in the CSP representation of the Hashi puzzle are the bridges. We represented the bridges with an adjacency matrix called `bridges`, where each element `bridges[i, j]` indicates the number of bridges between island i and island j. This matrix is symmetric, and the diagonal elements are zero because an island cannot connect to itself. B_{ij} is a variable that represents the number of bridges between the i-th and j-th islands. Where B_{ij} is symmetric and $B_{ii} = 0$.

2.2 Domains

The domain of each variable `bridges[i, j]` is $\{0, 1, 2\}$, representing the number of bridges between any two islands:

- 0 indicates no bridge.
- 1 indicates one bridge.

- 2 indicates two bridges.

Each B_{ij} is an integer variable where $B_{ij} \in \{0, 1, 2\}$.

2.3 Constraints

We implemented several constraints to govern the placement of bridges between islands:

1. **Bridge Validity:** Bridges must connect two distinct islands where $B_{ii} = 0$. And can only run orthogonally (either horizontally or vertically).

2. **Bridge Count Matching:** The total number of bridges connected to an island must match the number on the island.

3. **Non-Crossing Bridges:** Bridges cannot cross other bridges or islands.

4. **Symmetry:** The adjacency matrix `bridges` that represents the variables B_{ij} (the number of bridges between the i-th and j-th islands) is symmetric, meaning `bridges[i, j]` is equal to `bridges[j, i]` (B_{ij} is equal to B_{ji}).

5. **Connectivity:** All islands must be part of a single connected group. We verified this constraint as a post processing step by ensuring that there is a path of bridges connecting every island to every other island. We implemented this constraint through the use of Depth-First Search (DFS) on the adjacency matrix representing the bridges between islands.