Department of Computer Science and Engineering

Islamic University of Technology (IUT)

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Laboratory Report

CSE 4618: Artificial Intelligence Lab

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Section : BSc in SWE(A)
Semester : 6th

Lab No : 3

Question 1: Task 1:

Introduction:

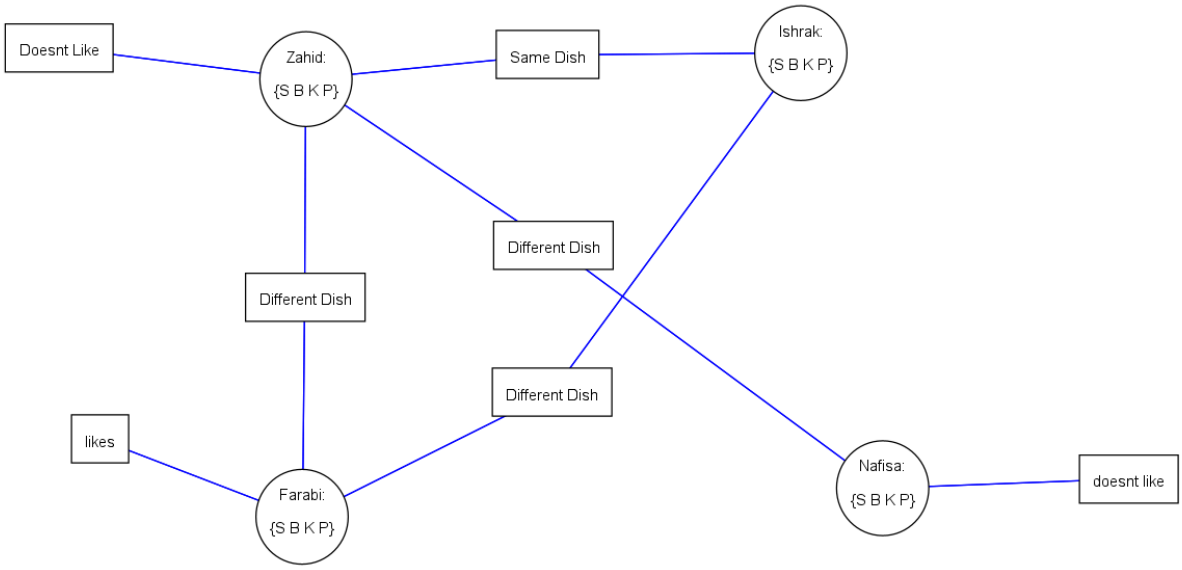
This problem states a number of food preferences between a group of people that hastobeformulated into a CSP The solution of CSP will give the possible combinations that will satisfy all the preferences stated

CSP Formation:

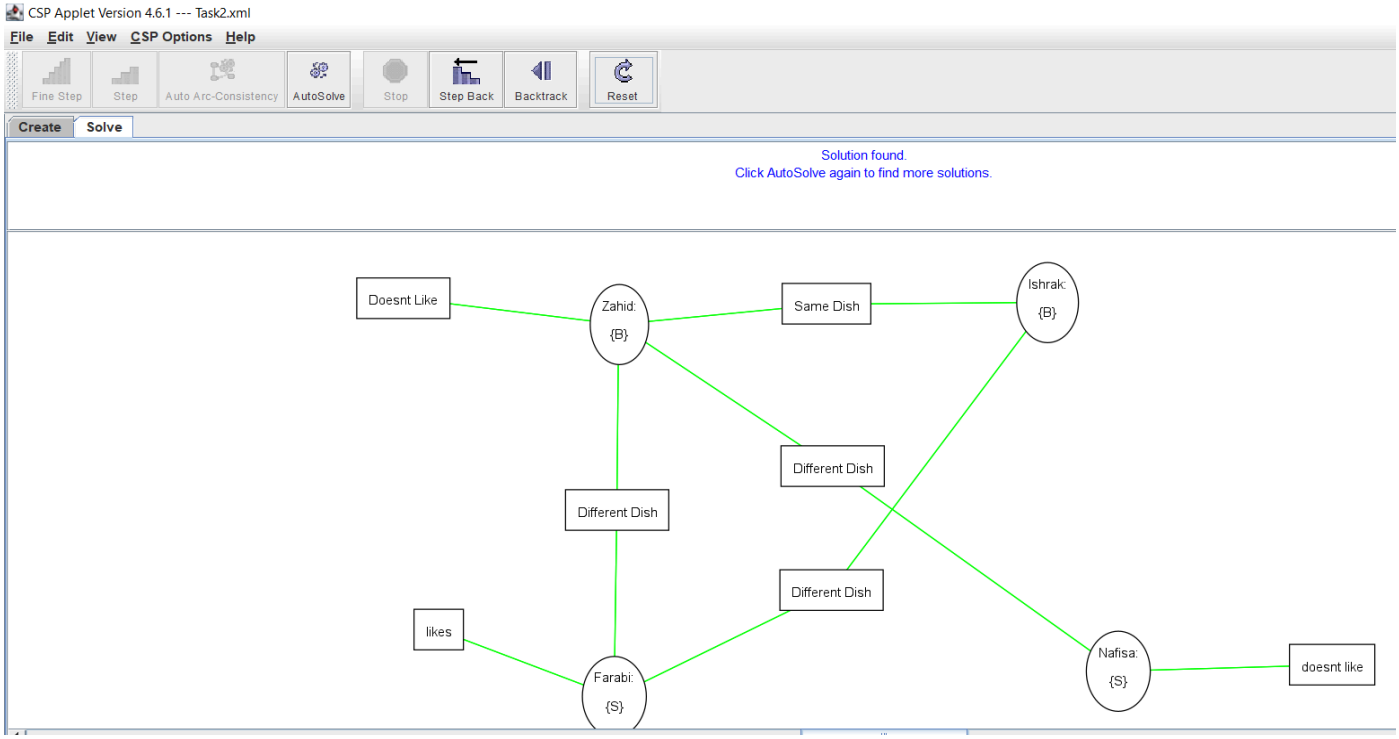
Since the problem requires assigning appropriate food preferences to the group, thefoodchoices are the domain and each person is considered as a variable, using the first letteroftheir name, that has to be assigned the value.

Domain = {S, B, K, P}, Variables = {Zahid, Ishrak, Farabi, Nafisa}

Considering the preferences stated, the resulting CSP formation is as given below.



Solution:



Problem Analysis In this problem

- Variables: Z, I, F, N
- Domains: {S,B,K,P}
- Constraints :
  - Z != Paratha
  - F = Rice Items
  - N != Kashmiri Naan
  - F != I
  - I = Z
  - F != Z
  - Z != N

Solution Explanation

● In this problem the variable domains are of type strings as the name of the foods can be represented using string easily rather than integers and they would be easier to track while introducing constraints among the variables.

● There are 2 types of constraints.
  ○ Unary constraints(Like Rice Items, No kashmiri nun Dislikes paratha)
  ○ Binary constraints(Same dishes, different dishes, likes , doesnt like)

● As Zahid likes to copy Ishrak so there would be no unique dish constraint between Zahid and Ishrak. Others will have a unique dish constraints with Zahid.

● Other constraints are straightforward as the lab manual specifies.

● At last we find the solution specified in the screenshots.

● There can be multiple solutions. If we click on auto solve again and again we will find other solutions as well.

Interesting Findings : No interesting finding for this task.

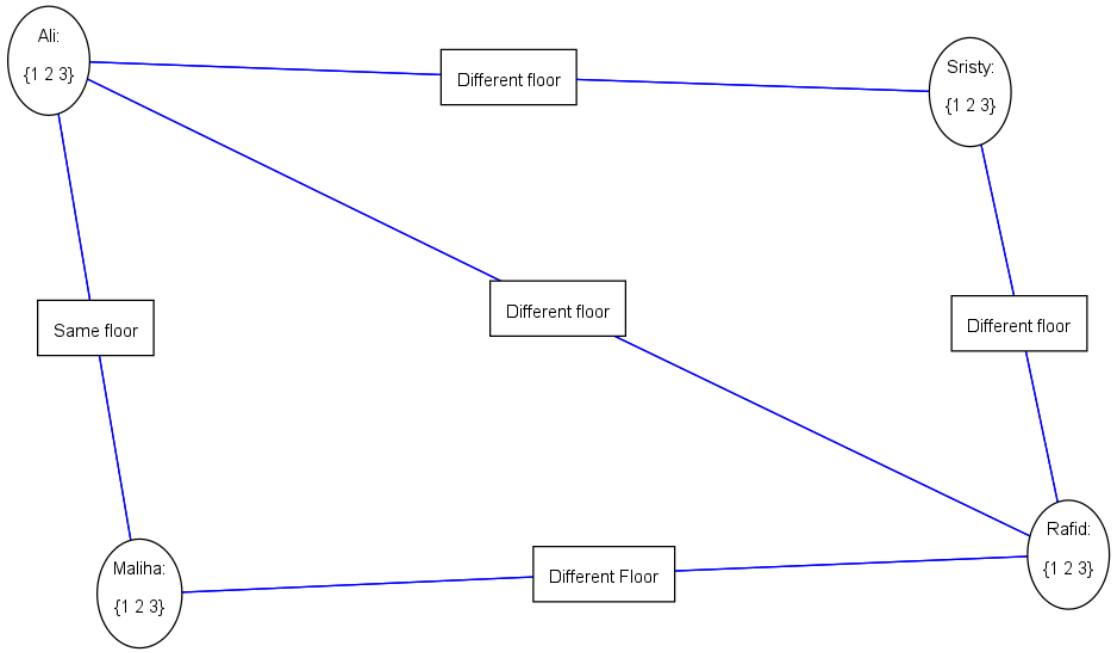
Challenges and Solution : No challenges faced during this task.

<u>Task 2(Finding Houses):</u>

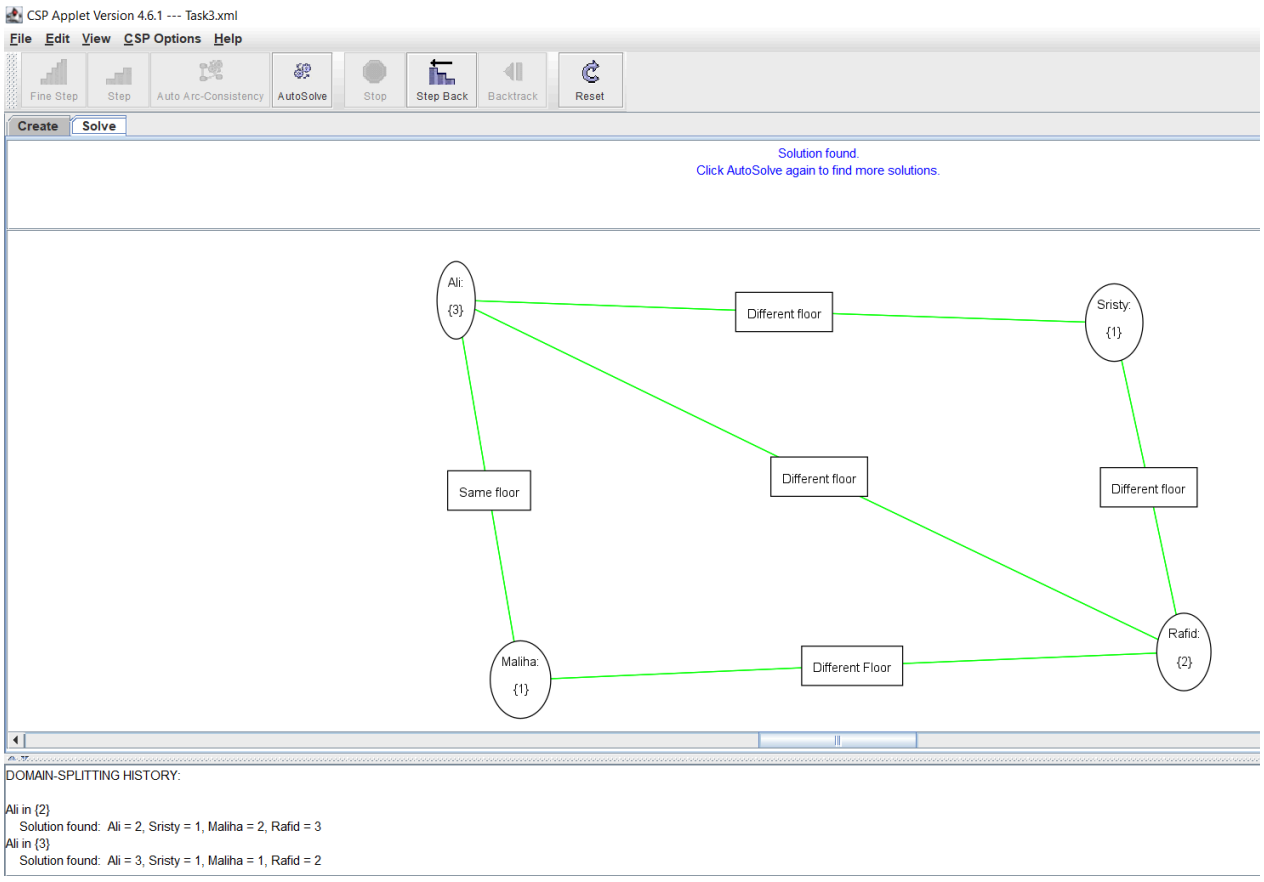
Introduction

Considering some constraints the problem asks us to formulate a CSP that assigns floors to 4 different people.

CSP Formation:



Solution:



Problem Analysis In this problem

- Variable: Ali, Sristy, Rafid, Maliha
- Domains: {1,2,3}
- Constraints:
  - S != A != R
  - R>M
  - A == M then A|M=2
  - A != M then A|M=3
  - R != M

- In this problem the variable domains are of type integers as the floors are easier to represent and the not equal constraint can be introduced like the upper picture.

- As Rafid won't live with any other on the same floor that means (Different floor) constraint would be introduced to each one with Rafid. But Rafid must live on a higher floor than Maliha (Different floor) constraint would be introduced.

- Other constraints are straightforward as the lab manual specifies. ● At last we find the solution specified in the screenshots.

- There can be multiple solutions. If we click on auto solve again and again we will find other solutions as well.

Interesting Findings

No interesting finding for this task.

Challenges and Solution

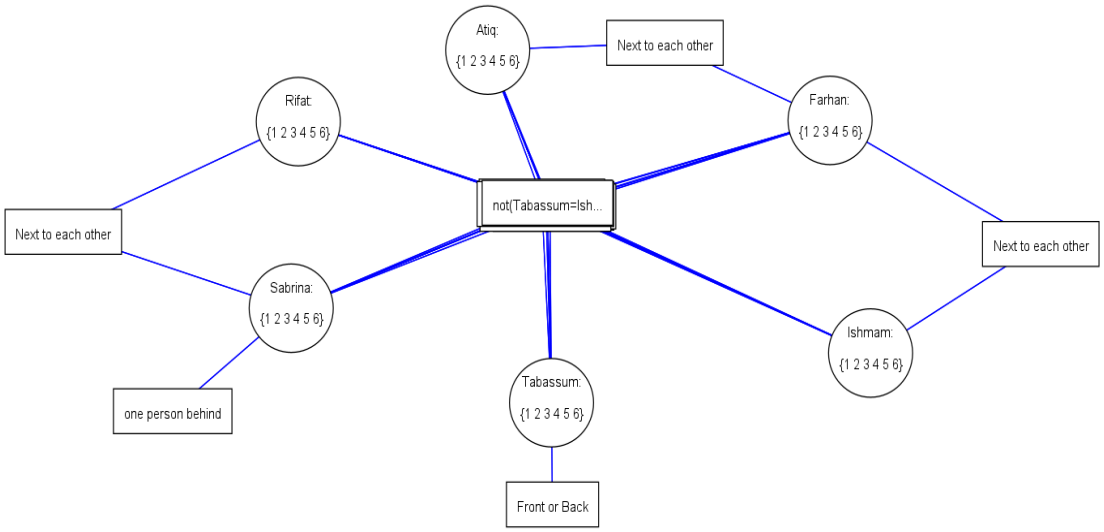
No challenges faced for this task.

Task 3(Spots):

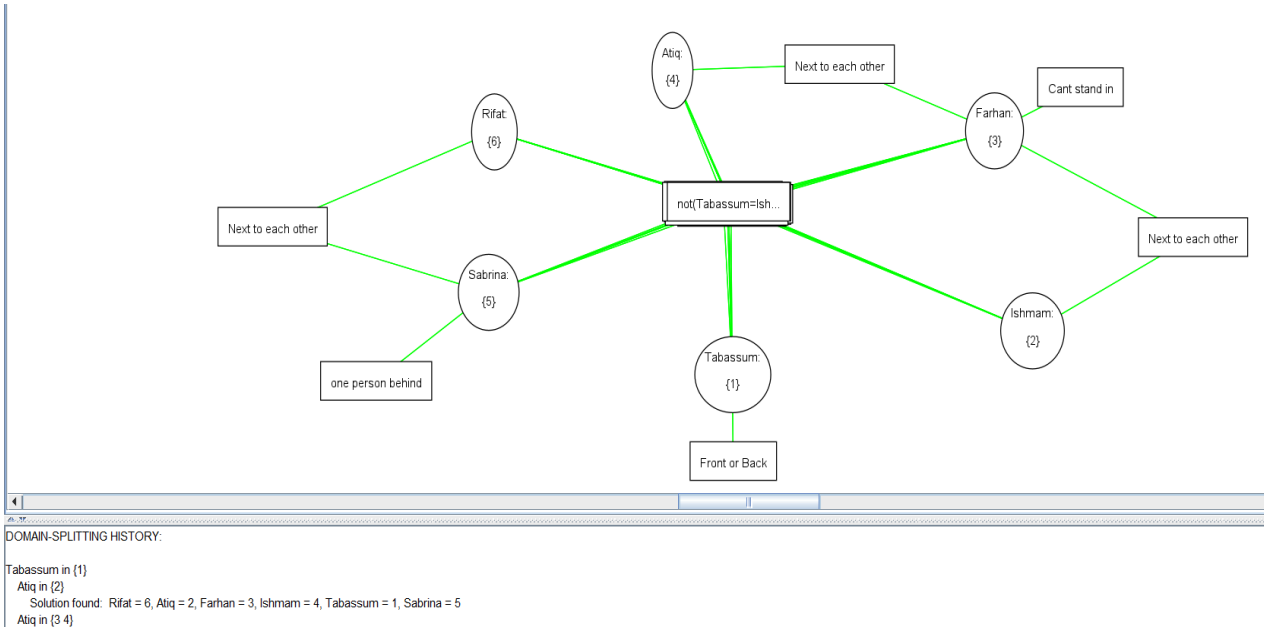
Introduction

Considering some constraints the problem asks us to formulate a CSP that assigns positions to six people in a queue

CSP Formation:



Solution:



Problem Analysis In this problem

- Variables: Ishmam, Tabassum, Sabrina, Farhan, Atiq, Rifat
- Domains: {1,2,3,4,5,6}
- Constraints:
  - AllDiff(Ishmam, Tabassum, Sabrina, Farhan, Atiq, Rifat)
  - $|F - A| = 1$
  - $|F - I| = 1$
  - $|S - R| = 1$
  - $T \in \{1, 6\}$
  - $S = 5$

- AllDiff has been represented using not equal constraints among all the variables.

Solution Explanation

- In this problem the variable domains are of type integers as the positions would be easier to represent and the not equal constraint can be introduced like the picture.

- There are 2 types of constraints.
  - Unary Constraints($T \in \{1, 6\}$,$S = 5$)
  - Binary Constraints(AllDiff(Ishmam, Tabassum, Sabrina, Farhan, Atiq, Rifat), $|F - A| = 1$, $|F - I| = 1$, $|S - R| = 1$)

- Farhan is standing in between Atiq and Ishmam. So the difference between their positions with Farhan would be 1.

- As Sabrina and Rifat are standing next to each other their position difference would be 1 also.

- At last we find the solution specified in the screenshots.

- There can be multiple solutions. If we click on auto solve again and again we will find other solutions as well.

Interesting Findings and Challenges

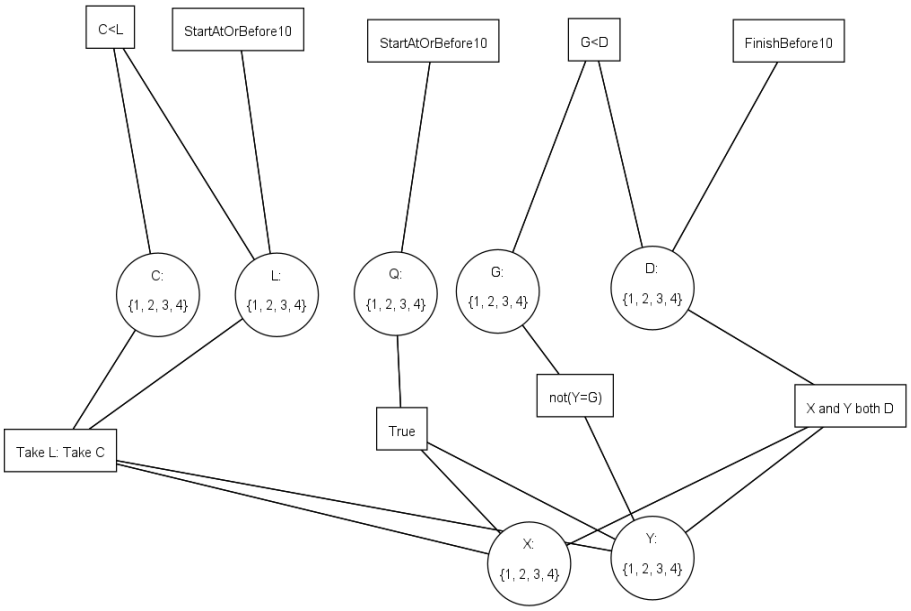
In this problem, I found that instead of applying all diff to all the variables at once, it works just fine if it applied to all possible binary constraints of the variables. I also discovered the magic of editing the XML file, which can save the trouble of manually clicking through the truth table one by one. The all diff was difficult to implement for each combination of binary constraints because the manual process might be prone to error. This was solved by editing the XML file and simply copying and pasting the truth table for different combinations of the variables. In this way, the truth table needs to be implemented just once in GUI of the Applet.

Task 4(Scheduling Task):

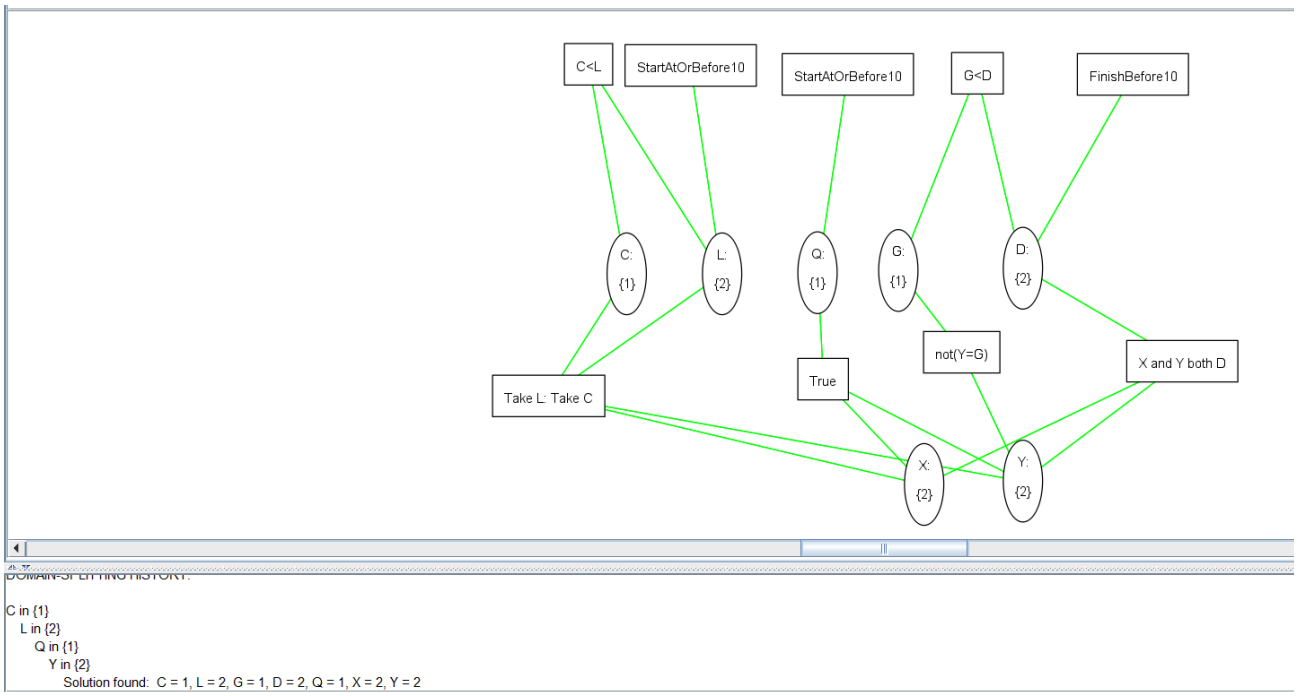
Introduction

Given 5 tasks and some constraints. We need to formulate a CSP and find a solution so that 2 faculty members X and Y get a schedule from 8am to 12am that satisfies all the constraints.

CSP Formation:



Solution:



Here we have two faculties, X and Y, along with 5 courses : C,L,Q,D and G. We also have 4 time slots, let's call them 1,2,3 and 4, representing 8am-9am, 9am-10am, 10am-11am, 11am-12am. So what we essentially end up doing is having X1, X2, X3, X4, Y1, Y2, Y3 and Y4 as the domain. The constraints for this problem are relatively complicated. In this problem, it took me a while to figure out how to use a new domain as a cartesian product of the domain {X,Y} representing faculties and the domain {1,2,3,4} to obtain the aforementioned domain.

A. Unary Constraints

• Gϵ X, where X ϵ {X1,X2,X3,X4}: This implies that only X does G as X is good at this
• L<=3, where L ϵ X1,X2,X3,Y1,Y2,Y3: L must be started at or before 10am which is slot 3
• Q<=3, where Q ϵ X1,X2,X3,Y1,Y2,Y3: Q must be started at or before 10am which is slot 3
• D<3, where Q ϵ X1,X2,Y1,Y2: D must be finished before 10am which is slot 2

B. Binary Constraints

• G<D: Time when D greater than G
• C<L: Time when L greater than C

C. Higher-Order Constraints
• No Multitasking: No faculty can do two things at the same time
• Q Takes 2: Q takes 2 periods, so no faculty can do anything for the next 2 periods
• L takes 2: Q takes 2 periods, so no faculty can do anything for the next 2 periods
• D involves 2: D involves both the faculties so no faculty can do anything else at that time
• Same Faculty must Take L and C, as AI Lab and Class has to be conducted by the same faculty

Now, another constraint that I ignored is that if X takes DBMS lab, s/he doesn't take the AI Lab, in my idea, it doesn't matter as even if X takes DBMS lab in a scheduling perspective this doesn't matter as both X and Y would be busy while the DBMS lab is going on.

Task5:

Introduction:

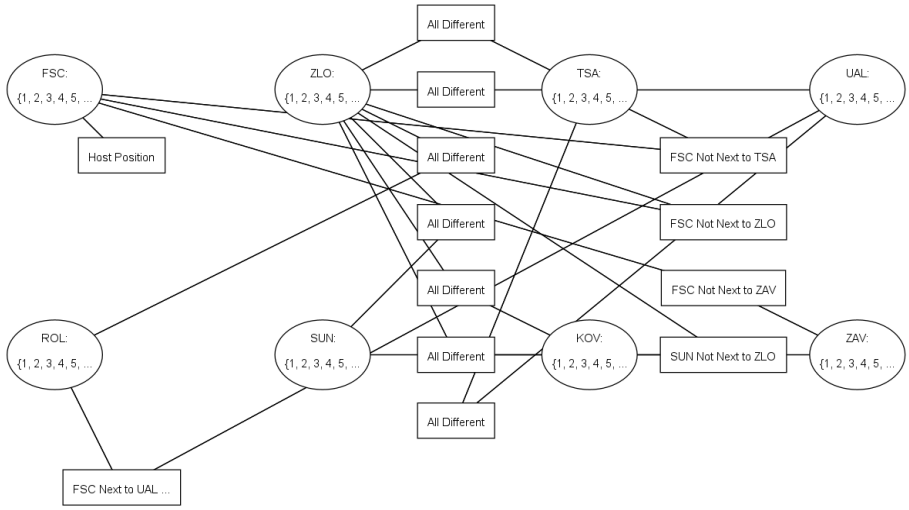
At an international peace summit, **eight ambassadors** from different fictional nations must be seated **around a circular table**. However, due to **political tensions, rivalries, and alliances**, there are several **seating constraints** that must be satisfied:

- Some ambassadors **refuse to sit next to certain others**.

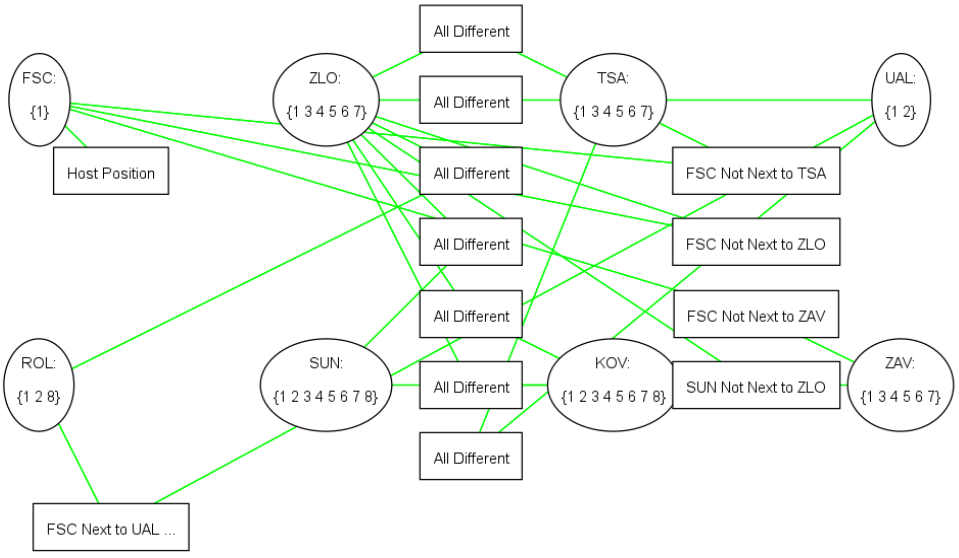
- Some must be **seated next to allies**.

- A few need to be **next to specific roles** like communicators.
- Additionally, a group called the **GHS (Global Harmony Supporters)** must be distributed such that **no more than two GHS members sit together in any group of three adjacent seats**.

CSP Formation



Solution:



Variables and Domain

- **8 Variables**: Each ambassador (FSC, ZLO, TSA, UAL, ROL, SUN, KOV, ZAV)
- **Domain**: Positions 1-8 around a circular table
- **Circular Table**: Position 1 is adjacent to positions 2 and 8, position 2 is adjacent to 1 and 3, etc.

Constraint Analysis

1. Fixed Constraint

- **FSC (host) must be at position 1** - This significantly reduces the search space

2. All-Different Constraints

- All remaining ambassadors (ZLO, TSA, UAL, ROL, SUN, KOV, ZAV) must occupy different positions
- This is a standard constraint ensuring no two ambassadors sit in the same position

3. Negative Adjacency Constraints

- **FSC cannot sit next to TSA, ZLO, or ZAV**
    - Since FSC is at position 1, TSA, ZLO, and ZAV cannot be at positions 2 or 8
- **SUN cannot sit next to ZLO**
    - If SUN is at position X, ZLO cannot be at positions X±1 (modulo 8)

4. Positive Adjacency Constraint

- **FSC must sit next to UAL or ROL (or both)**
    - Since FSC is at position 1, either UAL or ROL must be at position 2 or 8

Solution Approach

Step-by-Step Solution Process

1. **Start with Fixed Position**: FSC = 1
2. **Apply Positive Constraint**: UAL or ROL must be at position 2 or 8
    - This gives us 3 scenarios:
        - UAL at 2, ROL elsewhere
        - ROL at 8, UAL elsewhere
        - UAL at 2 and ROL at 8
3. **Apply Negative Constraints**:
    - TSA, ZLO, ZAV cannot be at positions 2 or 8
    - They must be placed at positions 3, 4, 5, 6, or 7
4. **Apply SUN-ZLO Constraint**:
    - Once ZLO's position is determined, SUN cannot be adjacent to it

Interesting Findings

1. Highly Constrained Problem

The combination of constraints creates a very restricted solution space. With FSC fixed at position 1 and multiple negative adjacency constraints, there are likely very few valid solutions.

2. Critical Positions 2 and 8

Positions 2 and 8 (adjacent to the host FSC) are the most constrained:

- Must contain UAL or ROL (or both)
- Cannot contain TSA, ZLO, or ZAV
- This leaves very limited flexibility