



CSE 4618: Artificial Intelligence Lab
Lab 3(Constraint Satisfaction Problem)

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Task 1(Eating Out):

Introduction

Given a set of constraints between 4 persons, the problem asks us to formulate a CSP and find a solution.

Screenshots of the formulation

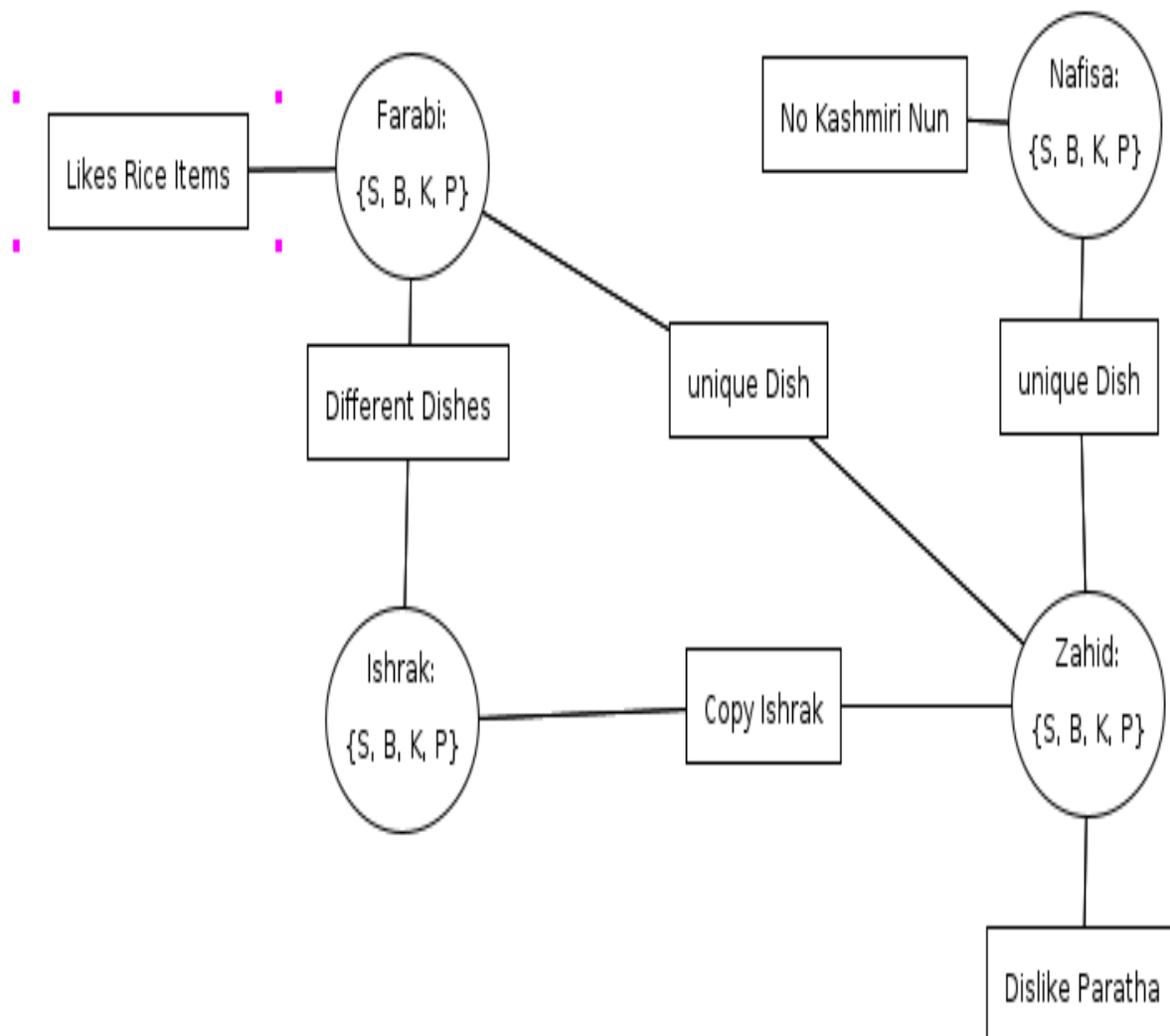


Fig 1.1: Eating out formulation.

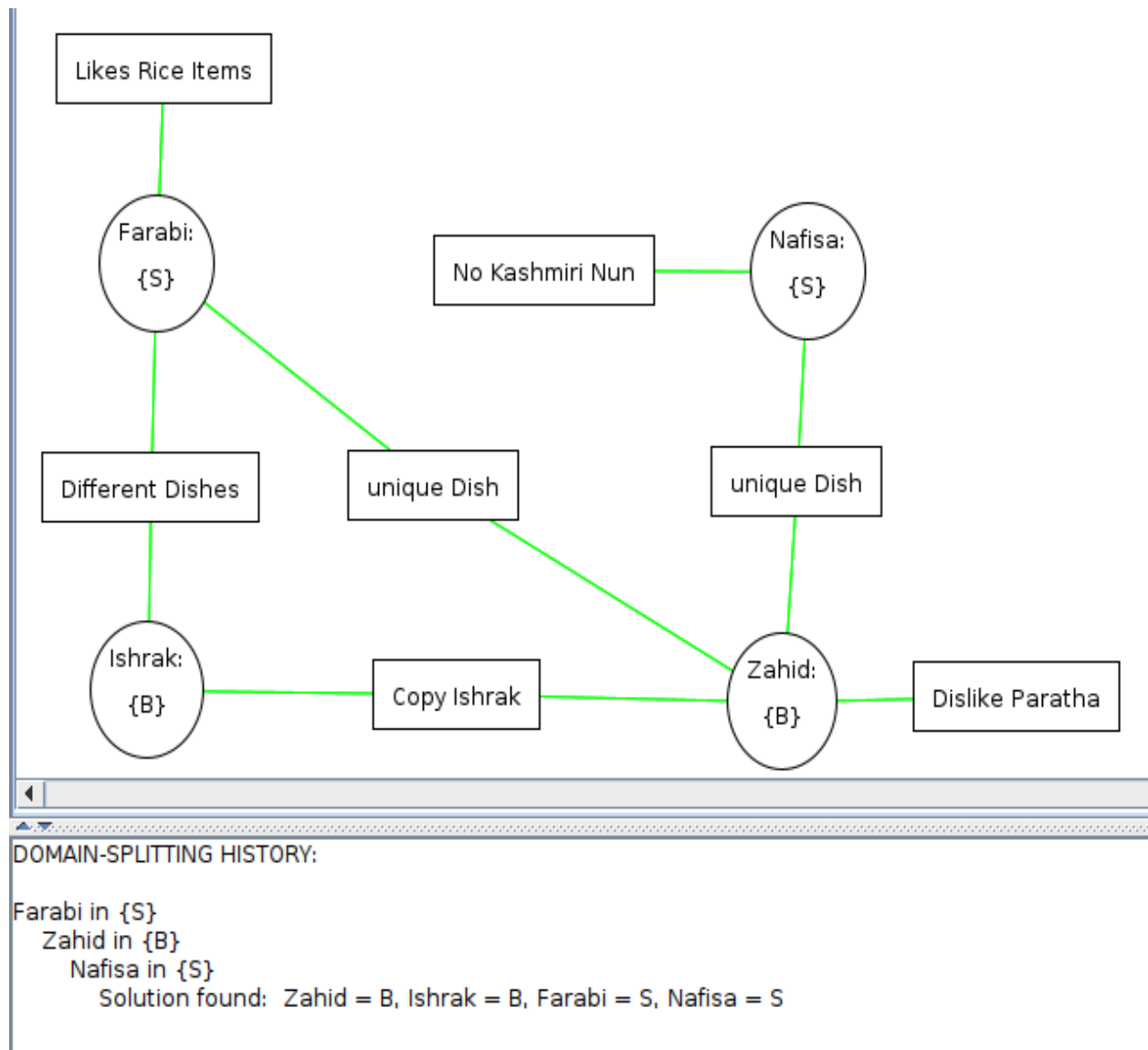


Fig 1.2: Eating out solution.

Problem Analysis

In this problem

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

- The circular shape defines the variables in this CSP and the square shape defines the constraints. Domains exist inside {Curly Braces} in the circular shape.

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(Copy ishrak, different dishes, unique dishes)
- As Zahid likes to copy Ishrak so there would be no unique dish constraint between Zahid and Ishrak. Others will have 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.

Task 2(Finding Houses):

Introduction

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

Screenshots of the formulation

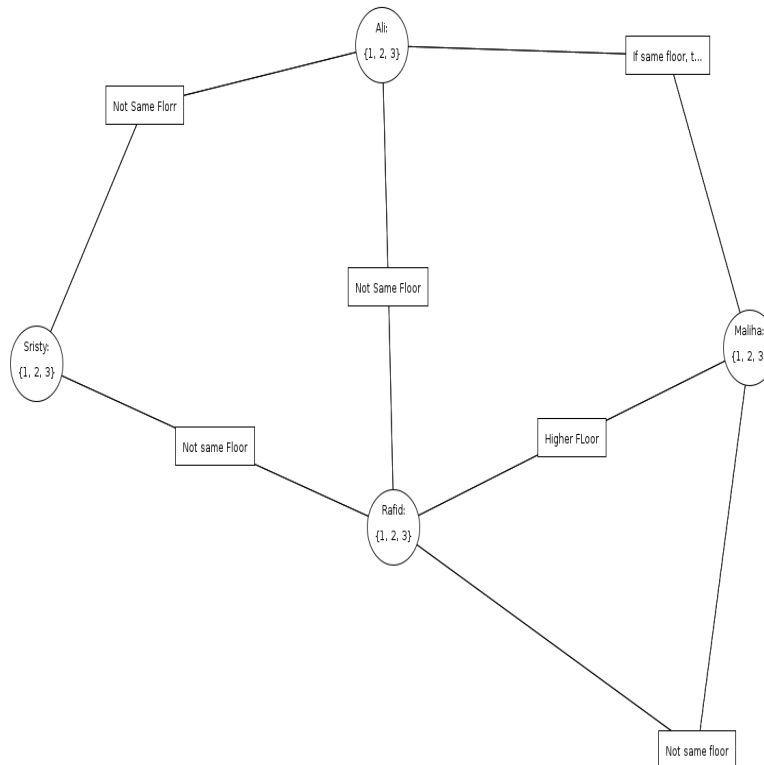


Fig 2.1:Finding Houses Formulation

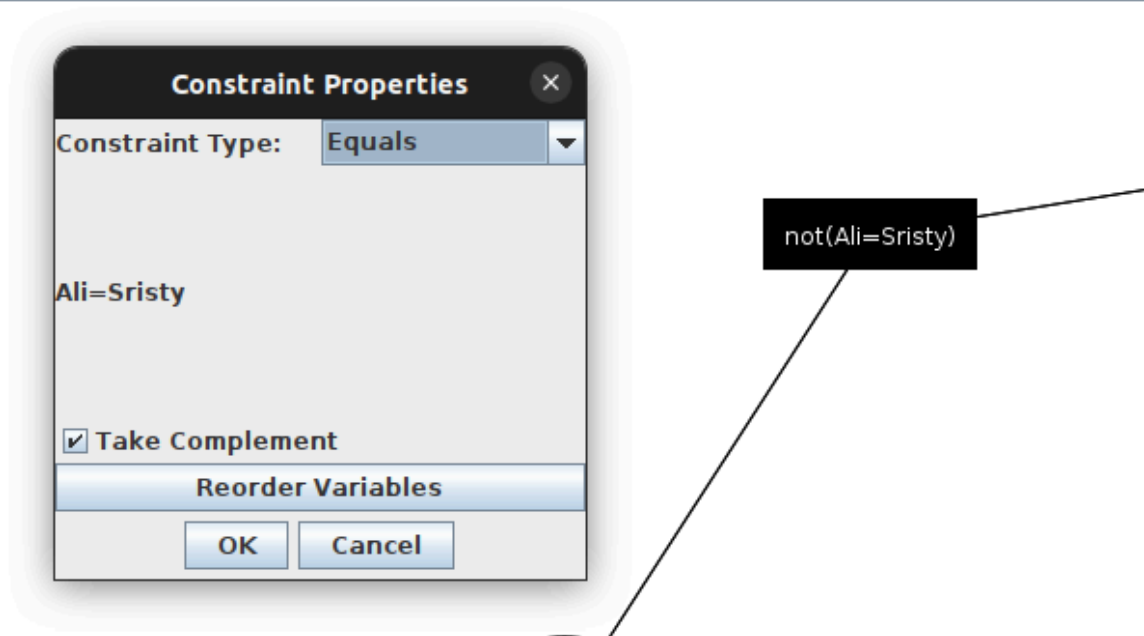


Fig 2.2: Using not equal constraint

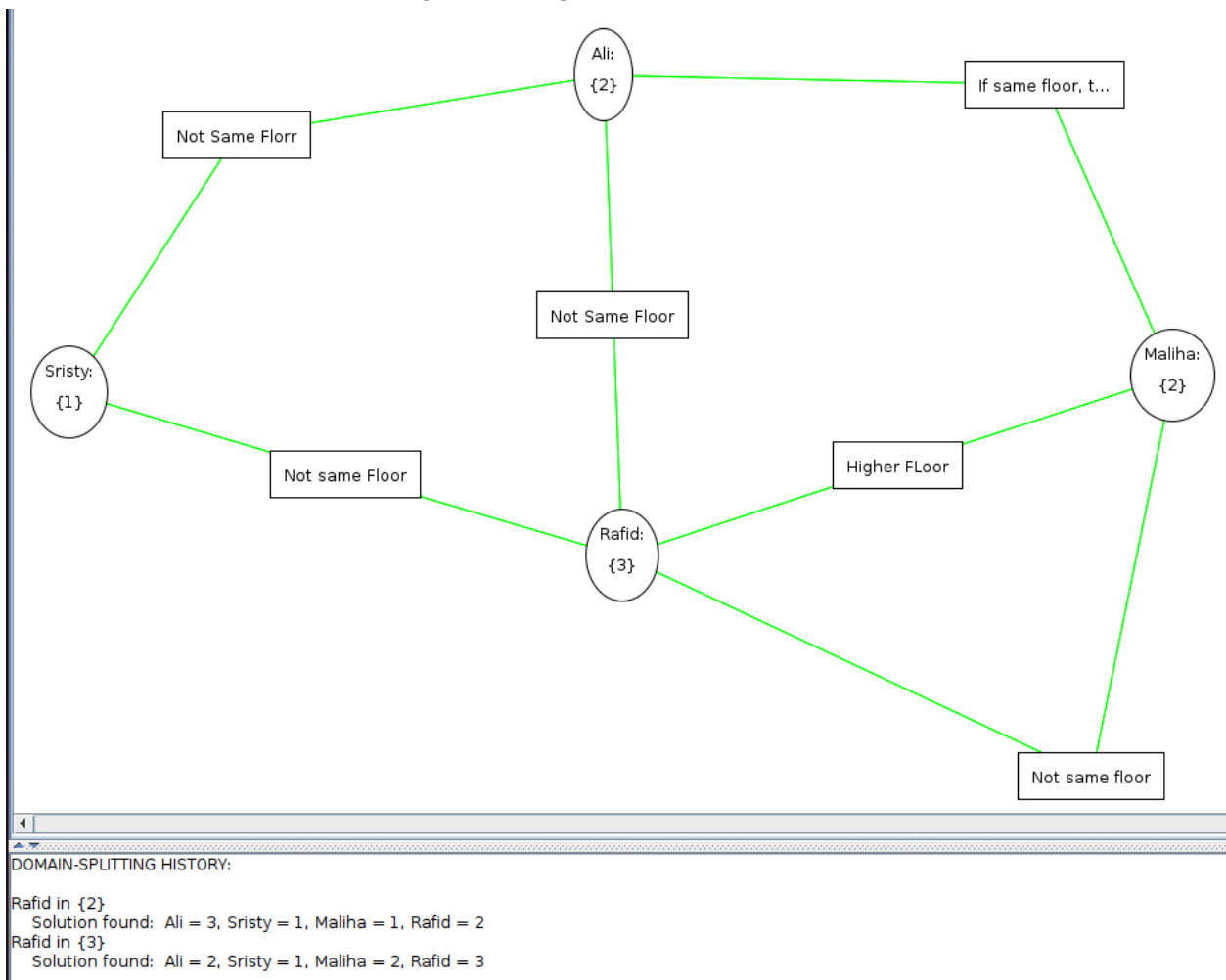


Fig 2.3: Finding Houses Solution

Problem Analysis

In this problem,

- Variable: Ali, Sristy, Rafid, Maliha
- Domains: {1,2,3}
- Constraints:
 - $S \neq A \neq R$
 - $R > M$
 - $A == M$ then $A|M=2$
 - $A \neq M$ then $A|M=3$
 - $R \neq M$
- The circular shape defines the variables in this CSP and the square shape defines the constraints. Domains exist inside {Curly Braces} in the circular shape.

Solution Explanation

- 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 Fig2.2.
- There are 1 type of constraint here.
 - Binary constraints(Not same floor, Higher Floor, if same floor, t..)
- As Rafid won't live with any other on the same floor that means (Not same floor) constraint would be introduced to each one with Rafid. But Rafid must live on a higher floor than Maliha (Not same 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.

Screenshots of the formulation

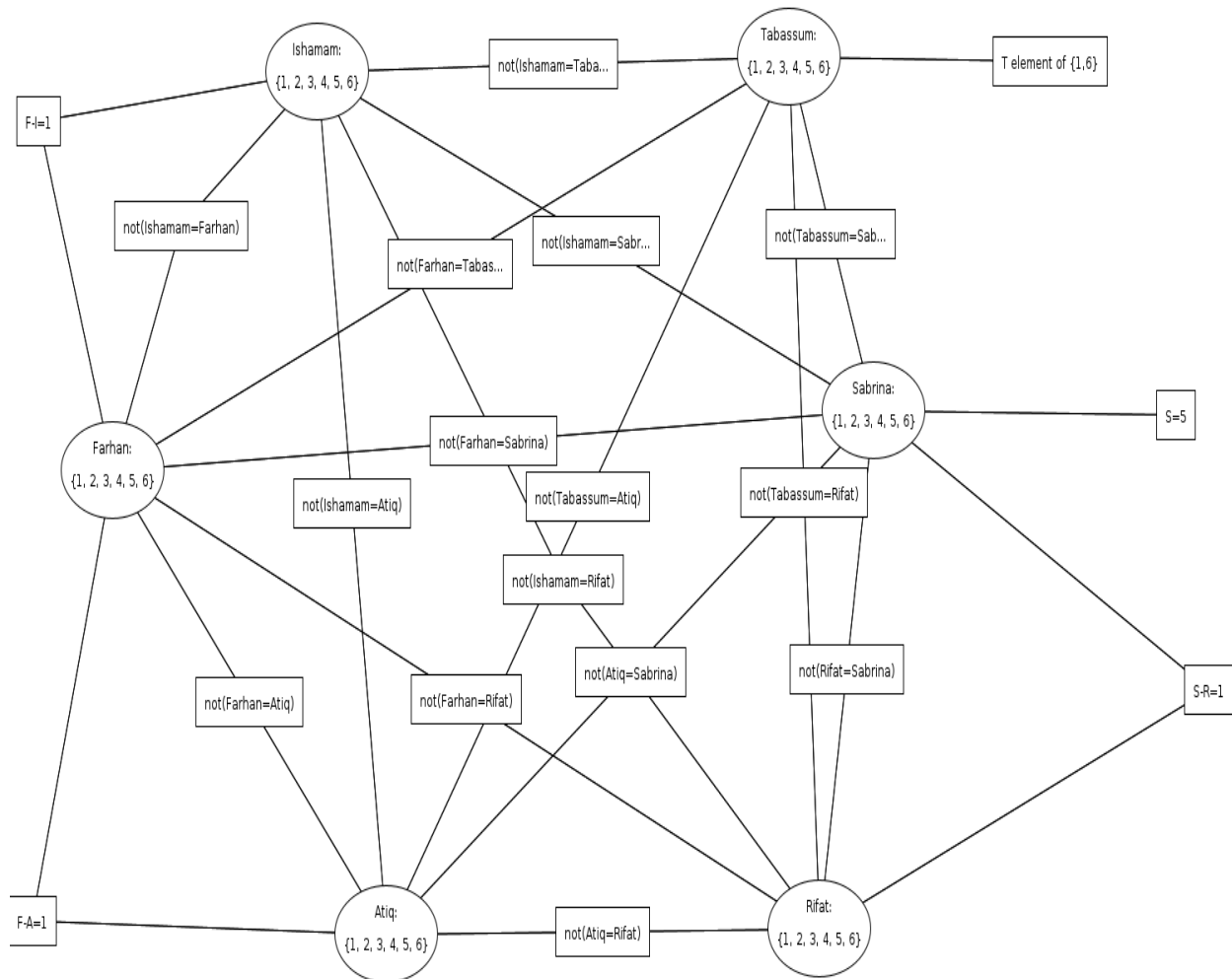


Fig 3.1: Spots formulation.

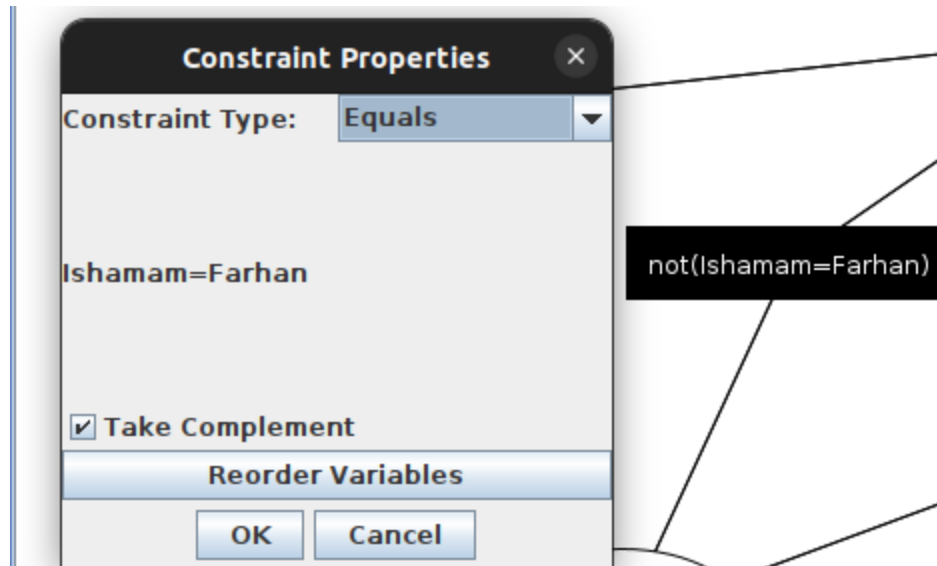


Fig 3.2: Using not equals constraint

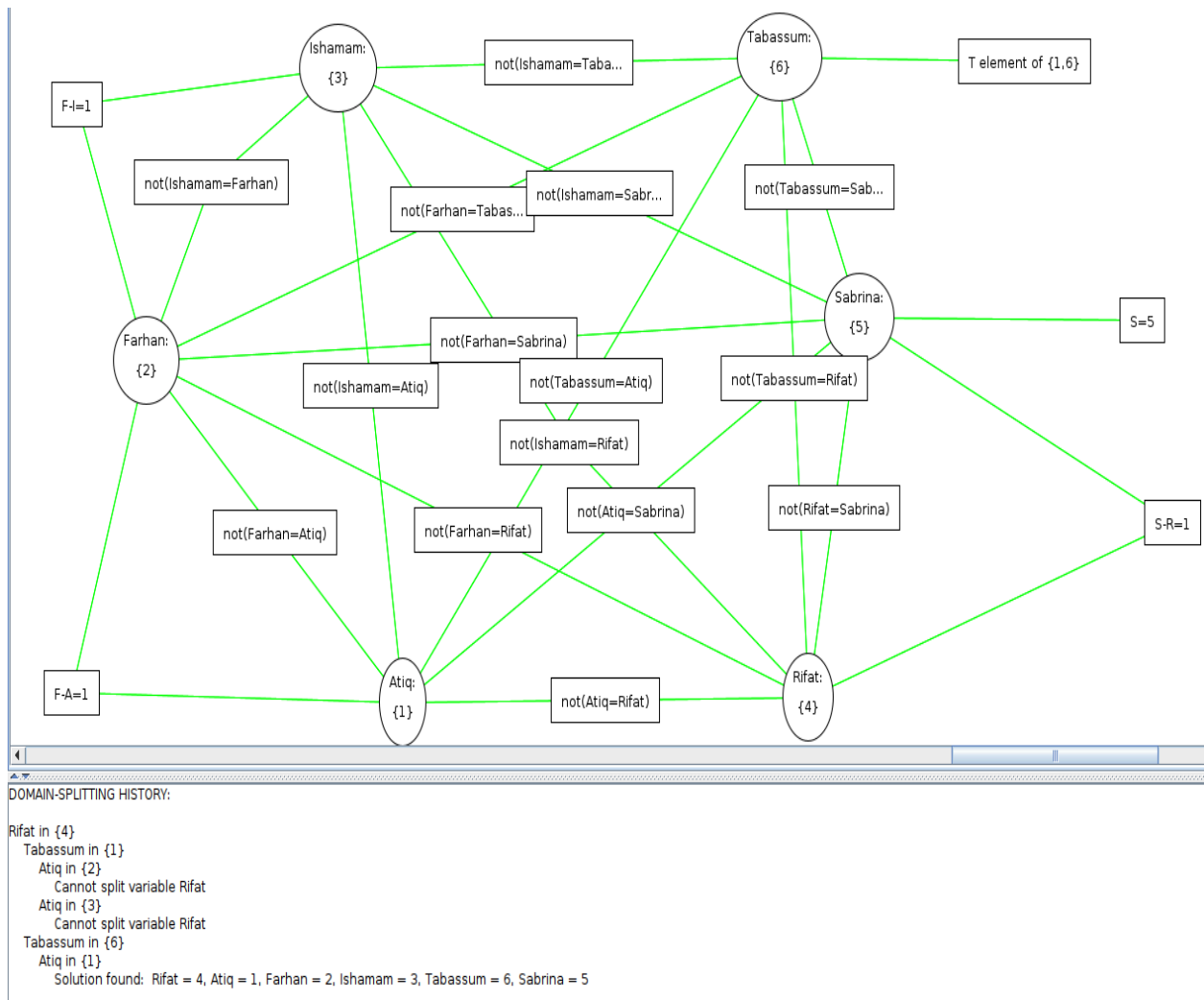


Fig 3.3: Spots solution

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.
- The circular shape defines the variables in this CSP and the square shape defines the constraints. Domains exist inside {Curly Braces} in the circular shape.

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 Fig 3.2.
- 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

No interesting finding for this problem.

Challenges and Solution

No challenges faced.

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.

Screenshots of the formulation

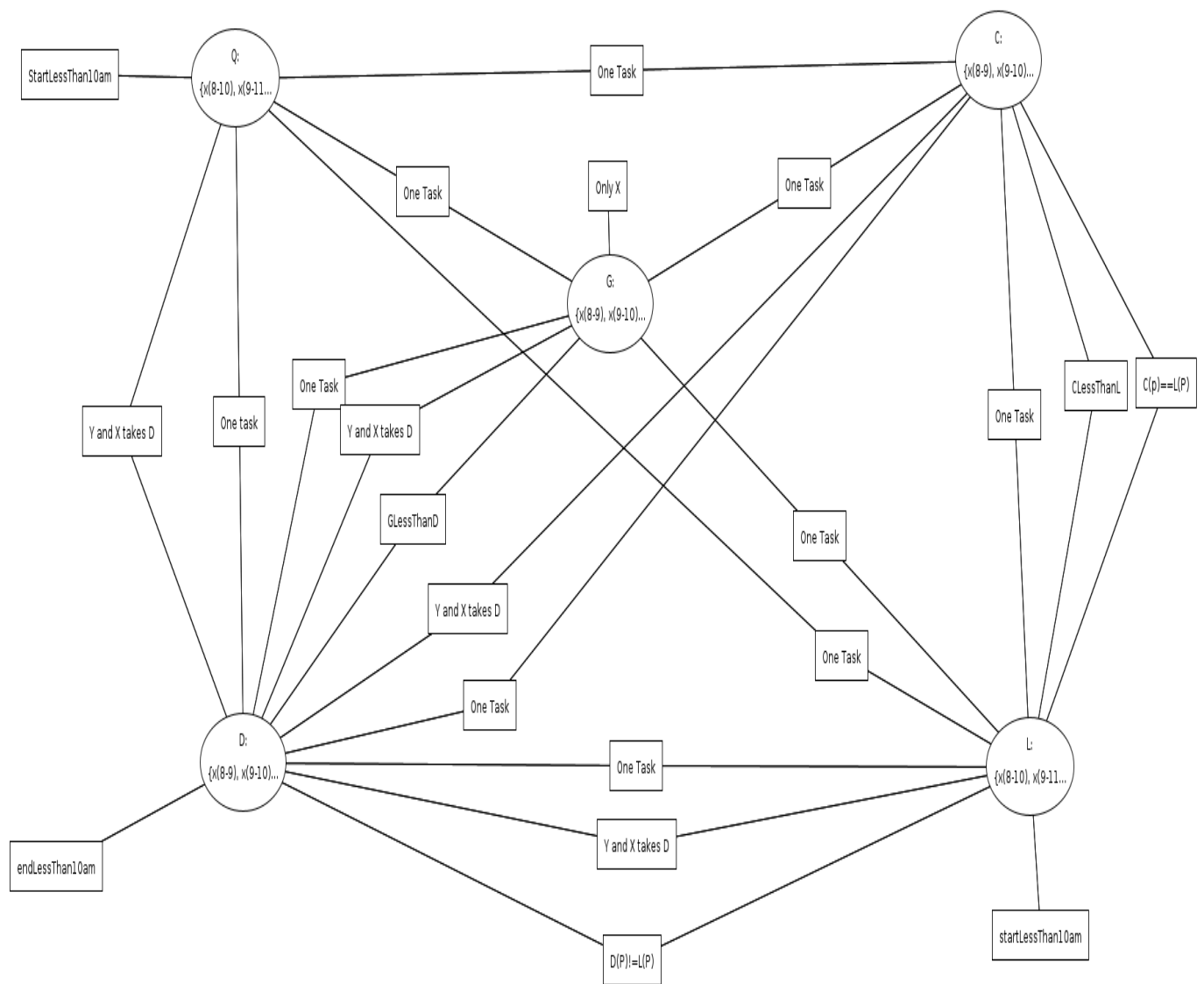


Fig 4.1: Scheduling Task Formulation

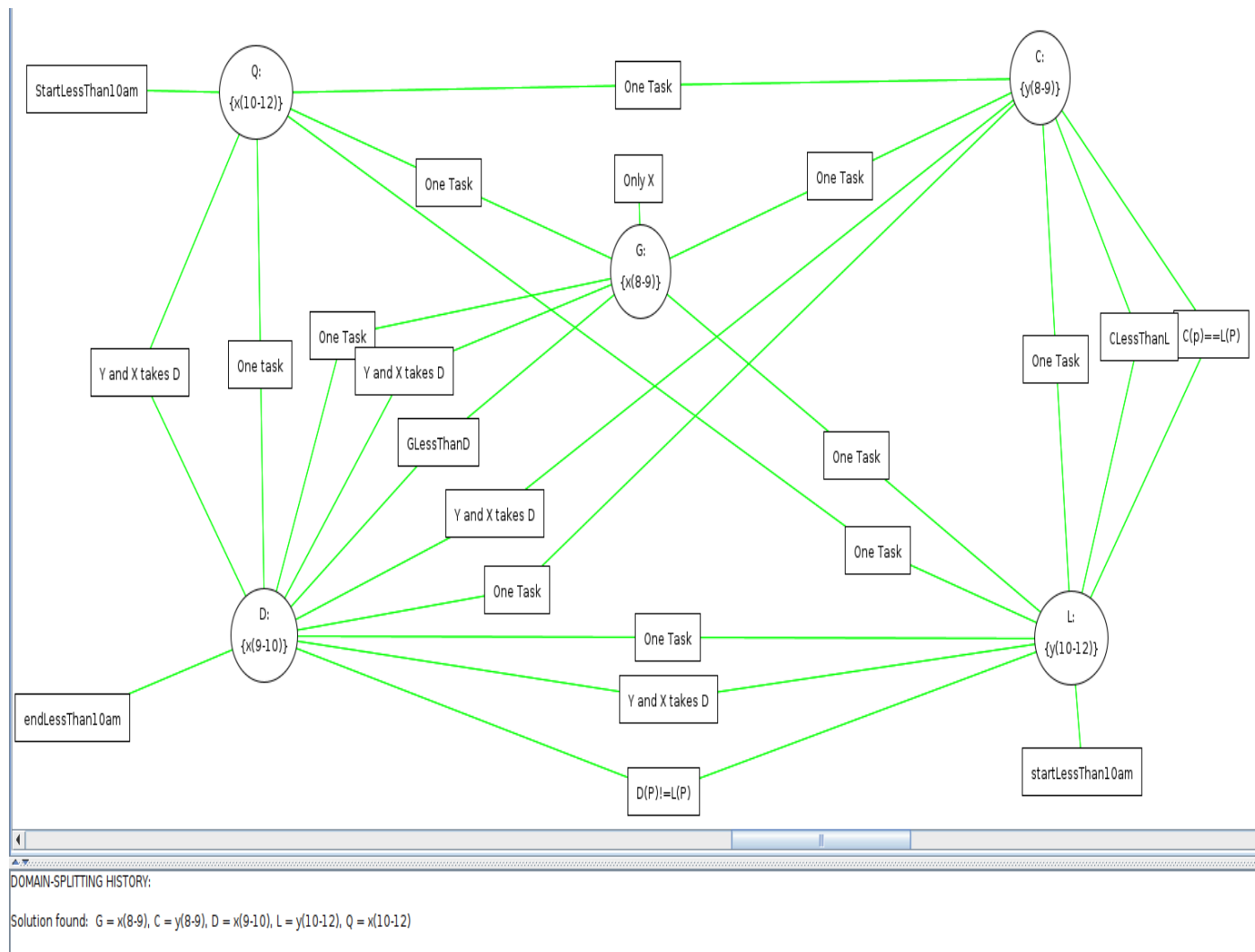


Fig 4.2: Scheduling Task Solution

Problem Analysis

In the problem,

- Variables: G,Q,C,D,L
- Domains: $\{x(8-9),x(9-10),x(10-11),x(11-12),y(8-9),y(9-10),y(10-11),y(11-12),x(8-10),x(9-11),x(10-12),y(8-10),y(9-11),y(10-12)\}$
- Constraints:
 - AllDiff(G,Q,C,D,L)
 - $Q < 10\text{am}$
 - Y and X takes D together for all variables
 - $\text{End } D < 10\text{am}$
 - $G < D$
 - Only X for G
 - $D(P) \neq L(P)$

- Start $L < 10\text{am}$
 - $C < L$
 - $C(P) == L(P)$
- The circular shape defines the variables in this CSP and the square shape defines the constraints. Domains exist inside {Curly Braces} in the circular shape.
- It is important to draw our attention to the fact that for Q & L variables domains have 2 hours difference as they take 2 consecutive hours to get completed. Rather than those all the other variables have 1 hour difference as domains.

Solution Explanation

- In this problem we are taking variables of domain type strings. Because the problem asks us to schedule the tasks between two faculties and there are different time duration of the tasks.
- If we tried to take integers it would have been difficult to track the X and Y faculty members.
- If we tried to take a boolean, it would be a very bad choice as we could never incorporate the constraints and the variables.
- But taking string into account can get us to a different domain to those variables that needs 2 hours of time duration rather than 1. Also X and Y faculty could be separated also like the domains provided in problem analysis.
- There are two types of constraints here.
 - Unary Constraints(One Task, $G < D$, $C < L$, $C(P) == L(P)$ etc.)
 - Binary Constraints. ($\text{start} < 10\text{am}$, $\text{end} < 10\text{am}$, Only Y, Only X)
- As the problem states that G can be done only by X then D would be done by Y and X together. So at that time no other tasks can be performed by the faculty members. That's why the Y and X take D constraint has been introduced with all other variables from D.
- At a given time slot a person can not perform more than one task. So One Task constraint has been introduced by deselecting all the same time slots between all the variables.
- While introducing constraints between C and L we need to be careful that if we take a class after 10am then no lab can be conducted as class takes 1 hour. So, the lab would start at 11 am. But that can't be possible as after 12am we can not continue the schedule.
- All the other constraints have been introduced according to the lab manual.
- At last we will find the following schedule provided in the screenshot that satisfies all the constraints. Here, $G=x(8-9)$ signifies that x will perform G from 8am-9am. Same goes for all the others.

Interesting Findings

No interesting findings for this problem.

Challenges and Solution

As the problem obliges us to consider time duration of tasks and faculty members it was challenging to decide which type of domain we should choose. At last I found string would be a better choice for this problem after considering the problem that might be faced afterwards provided in the solution explanation section.

Note:

As this Lab is not related to any coding, “The behavior of the code for different hyperparameters” has been omitted for this report.