- Variables kin kn si values domain say ley rahy hain depends upon constraints.
- State is defined by variables X, with values from domain (D)

$C_i = (\text{scope}, \text{rel})$

Constraint Satisfaction Problem (CSP)

- CSP consists of 3 components (V, D, C)
- V is set of variables $\{V_1\ V_2 \cdots V_n\}$
- D is set of domain $\{D_1\ D_2\ D_3 \cdots D_n\}$ one for each variable.

(natural, whole no)

- C is set of constraints that specify allowable combination of values, $\{C_1\ C_2\ C_3 \dots\}$

goal is to find a combination of values for variables that satisfies all constraints

⇒ where scope is set of variables that participate in constraints.

⇒ Rel is relation that defines values that variables can take.

CSP differs from programming, bcz they don't tell how to solve a problem, they focus on what needs to be done to reach solution.

Example:

V_1	V_2
A	B
(1,2)	(2,4)

$C_1 = ((V_1, V_2), (V_1 \neq V_2))$

OR

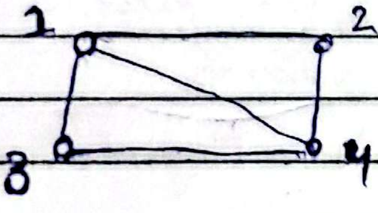
$C_1 = ((V_1, V_2), (A, B))$

$C_1 = ((V_1, V_2), (1,2)(1,4)(2,4))$

Example: intelligent.

We use backtracking method to solve CSP.

Intelligent backtracking aisi kiya hy q kay hum exact usi jagah pr jaa gae jahe conflict hoga.



$V = \{1, 2, 3, 4\}$

$D = \{\text{Red, Blue, Green}\}$

$C = \{1 \neq 2,\ 1 \neq 3,\ 1 \neq 4,\ 2 \neq 4,\ 3 \neq 4\}$

	1	2	3	4
Initial domain	R, G, B	R, G, B	R G B	R, G, B
1 = R	R	G B	G B	G B
2 = G	R	G	G B	B
3 = B	R	G	B	B empty
3 = G	R	G	G	D

- Varities of constraints.
  - Unary (SA ≠ green)
  - Binary (SA ≠ WA)
  - Higher-order constraints

- Constraint graph (nodes are variables, arcs (edges) are constraints)

- Standard search formulation (incremental)
  - It solves CSP by starting with an empty state and incrementally filling in values that satisfy constraints.
  - initial state (empty assignment)
  - Successor function (defines how to move forward by assigning a value to a variable that hasn't been assigned a value yet — It no valid assignment can be found, algorithm fails (backtrack to try new))
  - Goal test (when goal is achieved —
    - every variable is been assigned with value.
    - no constraints violated.

- Same for all CSP's
- use DFS
- Exact path doesn't matter as long as valid solution is reached. This allows to use of a complete-state formulation — entire state of problem is considered.

•– Backtracking search → DFS for CSP, with single Variable assignment

Commutative assignments { • In CSP's, order of variables does not matter. NT = green , green = NT.

Single variable assignment { • At each point in search, you can assign a value to one variable at a time then move to next unassigned Variable.

•– Most Constrained Variable. → Wo variable phly assign krna chahiye jis kay pass sb say kaam legal values hou:

Variable which holds less valid options, we have to assign value to it firstly.

• Also called as minimum remaining values (MRV) → purpose is to handle. that by handling most constrained variables firstly, we can reduce complexcity of finding a solution

• Wo variable select krtay hain jo baqi variables per sab say zaida constraints dalta hy.

- Least Constraining Value.
- Forward Checking.

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