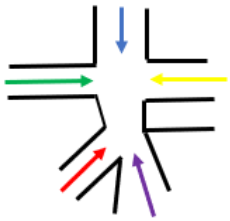
Rule of representation

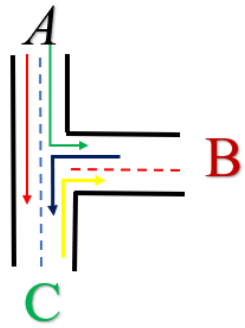
Example

3 Segments

A- One way

B&C Two ways





Goal

Design traffic light control pattern to make this intersection as safe as possible

1. Identify safe and unsafe trans (simultaneals)

	AB	AC	BC	CB
AB	■	O	✕	✕
AC	O	■	✕	O
BC	✕	✕	■	O
CB	✕	O	O	■

✕ Unsafe

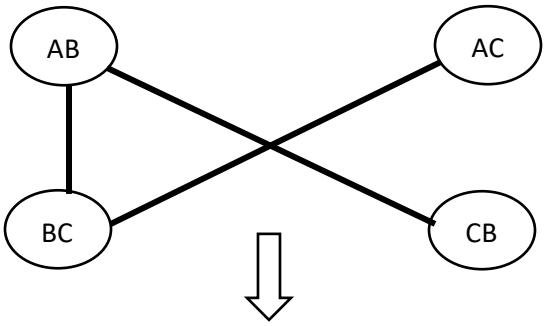
O Safe

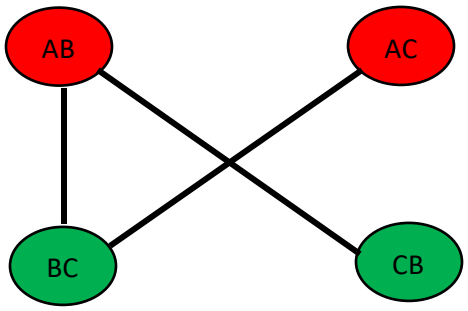
Using graph concept

G = < V, E > it can be directed and undirect graph

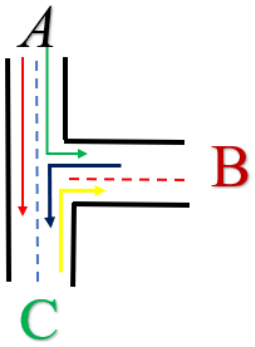
Vertices → trans

Edges → let the edge connect trans that are not compatible (unsafe)





Graph Coloring



How to come up with these colors

1. Problem description
2. Representation
3. Solution (method, algorithms ……..)

How do we color the graph?

Graph coloring

A greedy approach

1. Pick a node and color it with a color “X”.
2. Select any node with unconnected to the one you just colored and mark it with color “X”.
3. Repeat (2) until there are no have node you can color after “X”.
4. Pick another color and repeat 2and 3.

Representation

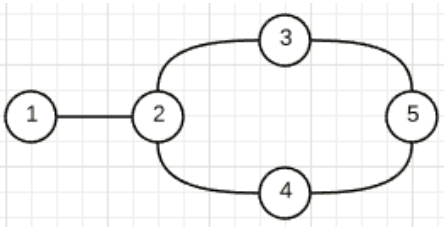
- Traffic
- Graph
- Graph Coloring

Greedy approach (pitfall)

Heuristic

- solving problem more efficiently at expense of optimality

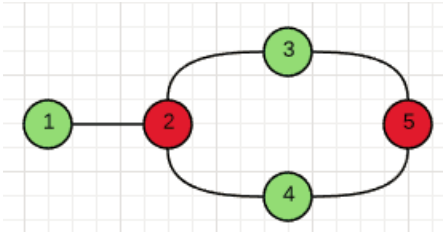
Example (pitfall)



- Label nodes with {1,2,3,4,5}
- In the particular order

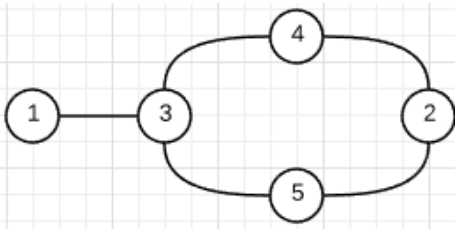
Order A

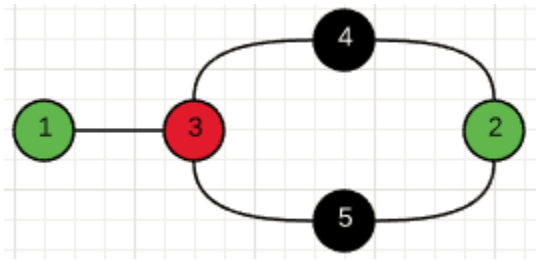
{1,2,3,4,5}



Order B

The same strategy that is pick up the node with lowest number





State Space

- Capture the condition / situation of system at point in the time

Example

8 Puzzle *initial state*

3X3 board with 9 tiles

{1,2,3,…..,8 and blank tile}

2	8	3
1	6	4
7		5

Goal state (final state)

1	2	3
8		4
7	6	5

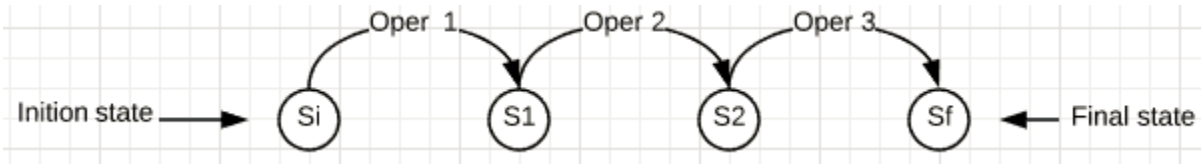
- To solve it; need to make a series of moves

Moves

- Up
- Down
- Left
- Right

In state space based approach, we define

1. State space
2. Initial state
3. Goal state
4. Operators moves / action that transfer / travers state space



5. Control strategy

8 Puzzle

1. State space

   B={(Tij) | i=1,2,3 ; j=1,2,3 ; Tij={1,2,..,8,balnk}

   And ⌐ (⌋ Tij & ⌋ Tkm such that Tij=Tkm for

   i j k m ={1,2,3}}

1	2	3
8		4
7	6	5

2. Initial state

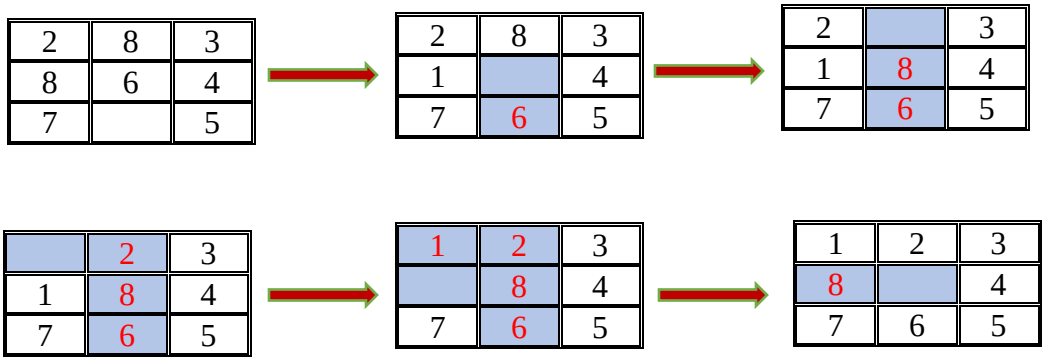
2	8	3
1	6	4
7		5

3. Goal state

1	2	3
8		4
7	6	5

4. Operators
   - Up Down Left Right

5. Control Strategy (CS)

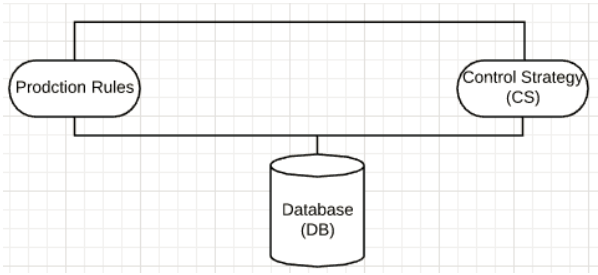


Solution is

- Up -----> Up --------> Left --------->Down ---------->Right

Continue with state space approach

- The concept of AI production system



  - ➢ DB → way of present State Space
  - ➢ Rules (operator) if < condition > Then < action >

Example of rule in the 8-puzzle problem

- Up
- Down
- Left
- Right

2	8	3
1	6	4
7		5

Changing state ⟶

2	8	3
1		4
7	6	5

- ➢ Control Strategy (CS) a method /a way to select an operator rule in such a way that allows us to solve problem

Procedure: - *production*

- D → Database (initial state)
- $\mathbb{R} \subseteq$ Operator (a set of applicable rules)

While $\mathbb{R} \neq 0$ *and D does not represent a goal state or does not meet termination condition.*

Begin

- ***R*** ← *Select* ($\mathbb{R}$)
- ***D*** ← *R (D)*
- ***Update*** ($\mathbb{R}$)

end

End

if blank in cell (1,3) then move blank (Right)

if blank in cell (1,8) then move blank (Up)

2	8	3
1	6	4
7		5

Example

8-Puzzle re-examine

- DB (database) 3X3 board {1,2,3,…..,8 and blank tile}
- Operators

  Translate move UP Down Left Right (U D L R) into production

  - If there exists no blank in top row
    and
    blank is in middle row
  - Then it can be moved UP
- Control Strategy (CS) → ? do later.

  Initial State / Goal state

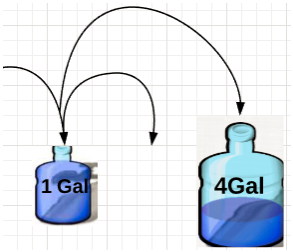
***Example** (3)*

Water Jug

Given two jugs with no marking on them with capacities of (4,3) gal respectively.

How can you fill in the (4) gal jug with exactly (2) gal.

Give the set of operators handed out in class.



AI production system

- DB { (x,y) | $0 \leq x \leq 4$, $0 \leq y \leq 3$ }

  For our instance the initial state Si (0,0)

  Goal state Sg = (2,y) such that $0 \leq y \leq 3$
- operators

***Example** (3)*

Water Jugs Problem

Given two jugs with no marking on them with capacities of (4, 3) gal respectively.

How can you fill in the (4) gal jug with exactly (2) gal.

Give the set of operators handed out in class.

AI production system

- DB { (x,y) | $0 \leq x \leq 4$, $0 \leq y \leq 3$ }

  For our instance the initial state Si (0, 0)

  Goal state Sg = (2, y) such that $0 \leq y \leq 3$

- Operators

  Initial state (0, 0)

  ↓

  Goal State (2, x)

Rules (3) & (4) Redundant

1	(X,Y | X<4) → (4,Y)	Fill the 4-gallon jug
2	(X,Y | Y<3) → (X,3)	Fill the 3-gallon jug
3	(X,Y | X>0) → (X-D,Y)	Pour some water out of the 4-gallon jug
4	(X,Y | Y>0) → (X,Y-D)	Pour some water out of the 3-gallon jug
5	(X,Y | X>0) → (0,Y)	Empty the 4-gallon jug on the ground
6	(X,Y | Y>0) → (X,0)	Empty the 3-gallon jug on the ground
7	(X,Y | X+Y>=4 ∧ Y>0) → (4,Y-(4-X))	Pour water from the 3-gallon jug into the 4-gallon jug until the 4-gallon jug is full
8	(X,Y | X+Y>=3 ∧ X>0) → (X-(3-Y),3)	Pour water from the 4-gallon jug into the 3-gallon jug until the 3-gallon jug is full
9	(X,Y | X+Y<=4 ∧ Y>0) → (X+Y,0)	Pour all the water from the 3-gallon jug into the 4-gallon jug
10	(X,Y | X+Y<=3 ∧ X>0) → (0,X+Y)	Pour all the water from the 4-gallon jug into the 3-gallon jug

- Control strategy (CS) to be discussed

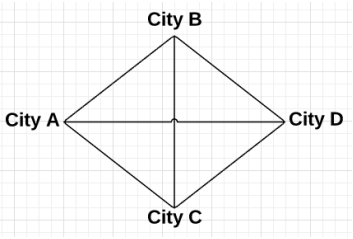
Solution

(0,0) → (4,0) → (1,3) → (1,0) → (0,1) → (4,1) → (2,3)

Example (4)

A traveling Salesman problem

A starting city (A) have to visit each city exactly once and return to start city.



Criterion

The path traveled should be minimum

- Distance → d_{ij}
- Cost →Cij

AI production system (PS) for traveling salesman problem (TSP)

- What is the database?
  - DB → list of cities visited so far (with a constraint)
    That no city other than starting city occurs twice

  - Operators

    1) If possible (that is a city has not been visited)
       Then go to city A next

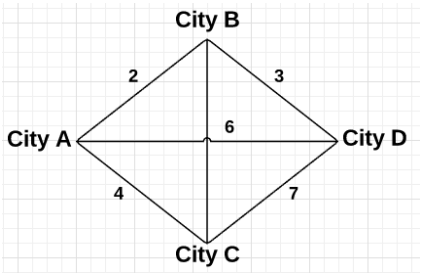
    2) If possible then go to city B next

    .

    .

    .

    h.) If possible go to N next



  - Control Strategy (CS)

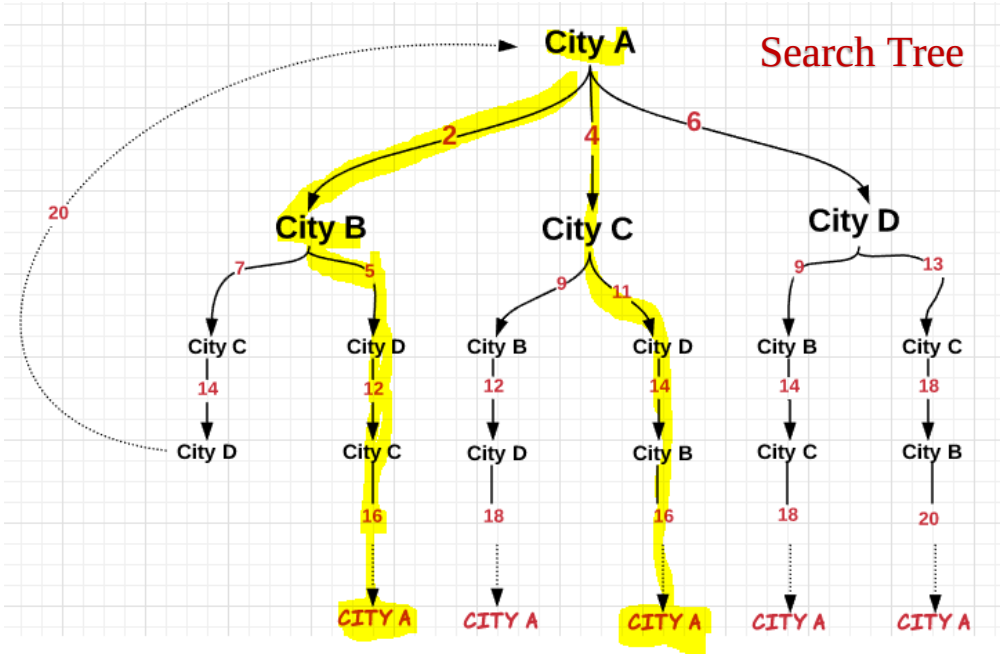
    ⟶ Greedy approach

    DB= 0 A → B → C → D

    DB= {A, B, D, C} = 16

  - Control Strategy (CS)

    ⟶ Exhaustive search



Control Strategy (CS)

- Desired Characteristics
    1) Systematic
    2) Cause motion
    3) Efficient