2. Eight Puzzle Problem

- It is also known as **eight puzzle problem** by the name of **N puzzle problem** or **sliding puzzle problem.**
- **N-puzzle** that consists of N tiles (N+1 titles with an empty tile) where N can be 8, 15, 24 and so on.

These types of problems have a **initial state or initial configuration (Start state) and a Goal state**

Here We are solving a problem **of 8 puzzle** that is **a 3x3 matrix.**

Initial state

1	2	3
	4	6
7	5	8

Goal state

1	2	3
4	5	6
7	8	

Solution:

The puzzle can be solved by moving the tiles one by one in the single empty space and thus achieving the Goal state.

Rules of solving puzzle

Instead of moving the tiles in the empty space we can visualize **moving the empty space** in place of the tile.

The empty space can only **move in four directions** (Movement of empty space)

1. Up
2. Down
3. Right or
4. Left

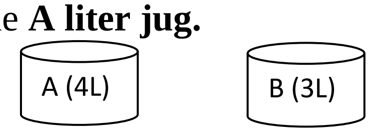
The empty space **cannot move diagonally** and can take **only one step at a time**.

3. Water Jug Problem:

There are two jugs of **volume A liter** and **B liter.** Neither has any **measuring mark** on it. There is a pump that can be used to fill the jugs with water.

Goal:-How can we get exactly **x liter** of water into the **A liter jug.**

Assuming that we have unlimited supply of water.



Note: Let's assume we have **A=4 litre and B= 3 litre jugs**.

Goal:-And **we want exactly 2 Litre water into jug A (i.e 4 litre jug)** how we will do this.

Solution: state space for this problem can be described as the set of ordered **pairs of integers (x,y)**

Where,
x represents the quantity of water in the 4-gallon jug x= 0,1,2,3,4
y represents the quantity of water in 3-gallon jug y=0,1,2,3

Initial State: (0,0) **Goal State: (2,0) or (2,n)**

Rule	Process	Production Rule /State
1	Fill 4-gallon jug	(X,Y | X<=4)->(4,Y)
2	Fill 3-gallon jug	(X,Y |Y<=3)->(X,3)
3	Empty 4-gallon jug	(X,Y |X>0) ->(0,Y)
4	Empty 3-gallon jug	(X,Y | Y>0)->(X,0)
5	Transfer water from 3-gallon jug into 4-gallon jug until 4-gallon jug is full	(X,Y | X+Y>=4 ^ Y>0)/ **(4,Y-(4-X))**
6.	Transfer water from 4-gallon jug into 3-gallon jug until 3-gallon jug is full	(X,Y | X+Y>=3 ^ X>0)/ **(X-(3-Y),3)**
7.	Transfer all water from 3-gallon jug into 4-gallon jug	(X,Y | X+Y<=4 ^ Y>0)/ (X+Y,0)
8.	Transfer all water from 4-gallon jug into 3-gallon jug	(X,Y | X+Y <=3 ^ X>0)/ (0,X+Y)
9.	Transfer 2 gallon water from 3 gallon jug into 4 gallon jug	(0,2)/(2,0)

Algorithm:
Initial step: Both Jugs are Empty
Result :(0, 0) Start State: (0,0)
Step1: **Apply Rule 1(**Fill 4 gallon Jug).
Current State: (4, 0)
Step2: **Apply Rule 6(**Transfer water from 4-gallon jug into 3-gallon jug)
Current State: (1, 3)

Step3: **Apply Rule 4(**Empty 3-gallon jug)
Current State: (1, 0)

Step4: **Apply Rule 8(**Transfer all water from 4-gallon jug into 3-gallon jug)
Current State: (0, 1)

Step5: **Apply Rule**1(Fill 4 gallon Jug)
Current State: (4,1)

Step6: **Apply Rule6(**Transfer water from 4-gallon jug into 3-gallon jug)
Current State: (2,3) **Goal State**

Water in A (4Gallon Jug)	Water in B (3Gallon Jug)	Rule Applied
0	**0**	Empty Jug(**Initial State)**
4	**0**	1(Fill 4 gallon Jug)
1	**3**	**6(**Transfer water from 4-gallon jug into 3-gallon jug)
1	**0**	**4.(** {Empty 3-gallon jug)
0	**1**	**8(**Transfer all water from 4-gallon jug into 3-gallon jug)
4	**1**	1(Fill 4 gallon Jug)
2	**3**	**6(**Transfer water from 4-gallon jug into 3-gallon jug) **Goal State**

Method:2

Water in A (4Gallon Jug)	Water in B (3Gallon Jug)	Rule Applied
0	**0**	Empty Jug(**Initial State)**
0	**3**	**Apply Rule 2:** Fill 3-gallon jug
3	**0**	**Apply Rule 7:** Transfer all water from 3-gallon jug into 4-gallon jug
3	**3**	**Apply Rule 2:** Fill 3-gallon jug
4	**2**	**Apply Rule 5:** Transfer water from 3-gallon jug into 4-gallon jug until 4-gallon jug is full
0	**2**	**Apply Rule 3:** Empty 4-gallon jug
2	**0**	**Apply Rule 9:** Transfer 2 gallon water from 3 gallon jug into 4 gallon jug