Example : Water Jug Problem

- **Problem statement**:
  - Given two jugs, a 4-gallon and 3-gallon having no measuring markers on them. There is a pump that can be used to fill the jugs with water. How can you get exactly 2 gallons of water into 4-gallon jug.
- **Solution**:
  - State for this problem can be described as the set of ordered pairs of integers (X, Y) such that
    - X represents the number of gallons of water in 4-gallon jug and
    - Y for 3-gallon jug.
  - Start state is (0,0)
  - Goal state is (2, N) for any value of N.

Production Rules

- Following are the production rules for this problem.
  - R1: $(X, Y \mid X < 4) \rightarrow (4, Y)$ {Fill 4-gallon jug}
  - R2: $(X, Y \mid Y < 3) \rightarrow (X, 3)$ {Fill 3-gallon jug}
  - R3: $(X, Y \mid X > 0) \rightarrow (0, Y)$ {Empty 4-gallon jug}
  - R4: $(X, Y \mid Y > 0) \rightarrow (X, 0)$ {Empty 3-gallon jug}
  - R5: $(X, Y \mid X+Y >= 4 \wedge Y > 0) \rightarrow (4, Y - (4 - X))$

    {Pour water from 3- gallon jug into 4-gallon jug until 4-gallon jug is full}
  - R6: $(X, Y \mid X+Y >= 3 \wedge X > 0) \rightarrow (X - (3 - Y), 3)$

    {Pour water from 4-gallon jug into 3-gallon jug until 3-gallon jug is full}

- R7: (X, Y | X+Y <= 4 Λ Y > 0) □ (X+Y, 0)
  {Pour all water from 3-gallon jug into 4-gallon jug }
- R8: (X, Y | X+Y <= 3 Λ X > 0) □ (0, X+Y)
  {Pour all water from 4-gallon jug into 3-gallon jug }

- Superficial Rules: {May not be used in this problem}

- R9: (X, Y | X > 0) □ (X – D, Y)
  {Pour some water D out from 4-gallon jug}
- R10: (X, Y | Y > 0) □ (X, Y - D)
  {Pour some water D out from 3- gallon jug}

Trace of steps involved in solving the water jug problem - First solution

No.of step	*Rules applied*	*4-g jug*	*3-g jug*	
1	**Initial State**	0	0	
2	R2 {Fill 3-g jug}	0	3	
3	R7{Pour all water from 3 to 4-g jug }	3	0	
4	R2 {Fill 3-g jug}	3	3	
5	R5 {Pour from 3 to 4-g jug until it is full}	4	2	
6	R3 {Empty 4-gallon jug}	0	2	
7	R7 {Pour all water from 3 to 4-g jug}	2	0	**Goal State**

Trace of steps involved in solving the water jug problem - Second solution

No. of step	*Rules applied*	*4-g jug*	*3-g jug*	
1	**Initial State**	0	0	
2	R1 {Fill 4-gallon jug}	4	0	
3	R6 {Pour from 4 to 3-g jug until it is full }	1	3	
4	R4 {Empty 3-gallon jug}	1	0	
5	R8 {Pour all water from 4 to 3-gallon jug}	0	1	
6	R1 {Fill 4-gallon jug}	4	1	
7	R6 {Pour from 4 to 3-g jug until it is full}	2	3	
8	R4 {Empty 3-gallon jug}	2	0	**Goal State**