TUTORIAL

BAYES NET

Problem Context:

A musician asks you to help him compose the next big Bollywood hit for the upcoming awards season. He uses his knowledge of the Indian music industry to create a probability table with six (6) boolean variables, but he needs your assistance in analyzing the table.

A MUSICIAN ASKS YOU TO HELP HIM COMPOSE THE NEXT BIG BOLLYWOOD HIT FOR THE UPCOMING AWARDS SEASON. HE USES HIS KNOWLEDGE OF THE INDIAN MUSIC INDUSTRY TO CREATE A PROBABILITY TABLE WITH SIX (6) BOOLEAN VARIABLES, BUT HE NEEDS YOUR ASSISTANCE IN ANALYZING THE TABLE.

- Without making any assumptions about independence, how many parameters do we need in the joint probability table?

- Musician realizes that without any independence assumptions, the joint probability table becomes unmanageably large. To make his model computationally feasible with his six (6) boolean variables, he defines the Bayes net shown below, allowing him to rely on the Bayes net's independence assumptions. Assume that only the independence statements dictated by the structure of the net are valid. How many parameters are required for this Bayes net?

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True or False. Justify.

$P(A \mid CE) = P(A \mid E)$

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True or False. Justify.

A and D are marginally independent

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True or False. Justify.

E and B are conditionally independent, given D

PLANNING

Goal: To replace a flat tire on the car axle with a spare tire.

- Derive the plan using partial-order planning algorithm and show step by step solution
- Derive the plan using GraphPlan algorithm. Show step by step solution.

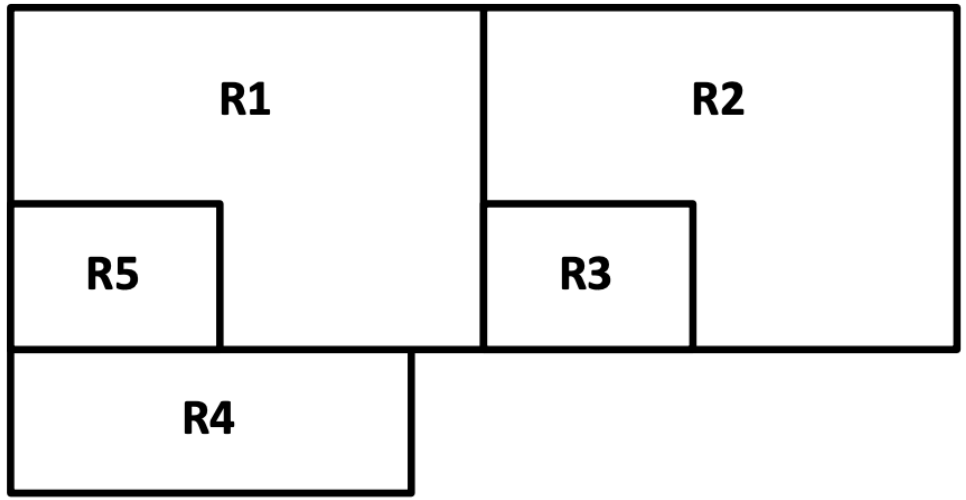
$$
\begin{aligned}
&Init(At(Flat, Axle) \ \wedge \ At(Spare, Trunk)) \\
&Goal(At(Spare, Axle)) \\
&Action(Remove(Spare, Trunk), \\
&\quad \text{PRECOND: } At(Spare, Trunk) \\
&\quad \text{EFFECT: } \neg\, At(Spare, Trunk) \ \wedge \ At(Spare, Ground)) \\
&Action(Remove(Flat, Axle), \\
&\quad \text{PRECOND: } At(Flat, Axle) \\
&\quad \text{EFFECT: } \neg\, At(Flat, Axle) \ \wedge \ At(Flat, Ground)) \\
&Action(PutOn(Spare, \ Axle), \\
&\quad \text{PRECOND: } At(Spare, Ground) \ \wedge \ \neg\, At(Flat, Axle) \\
&\quad \text{EFFECT: } \neg\, At(Spare, Ground) \ \wedge \ At(Spare, Axle)) \\
&Action(LeaveOvernight, \\
&\quad \text{PRECOND:} \\
&\quad \text{EFFECT: } \neg\, At(Spare, Ground) \ \wedge \ \neg\, At(Spare, Axle) \ \wedge \ \neg\, At(Spare, Trunk) \\
&\qquad\qquad \wedge \neg\, At(Flat, Ground) \ \wedge \ \neg\, At(Flat, Axle))
\end{aligned}
$$

GRAPHPLAN

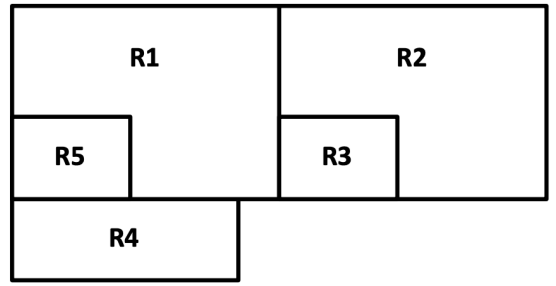
```
function GRAPHPLAN(problem) returns solution or failure

    graph ← INITIAL-PLANNING-GRAPH(problem)
    goals ← GOALS[problem]
    loop do
        if goals all non-mutex in last level of graph then do
            solution ← EXTRACT-SOLUTION(graph, goals, LENGTH(graph))
            if solution ≠ failure then return solution
            else if NO-SOLUTION-POSSIBLE(graph) then return failure
        graph ← EXPAND-GRAPH(graph, problem)
```

CONSTRAINT SATISFACTION PROBLEM (CSP)

You are an interior designer hired by a luxury hotel to design a new VIP suite. The suite includes five rooms labeled R1 through R5, each needing a specific function assignment: Bedroom, Living Area, Kitchen, Dining Room, or Water Closet (Restroom). Your task is to designate the best function for each room based on the client's needs and preferences. Here is the suite's floorplan with each room labeled for your reference.

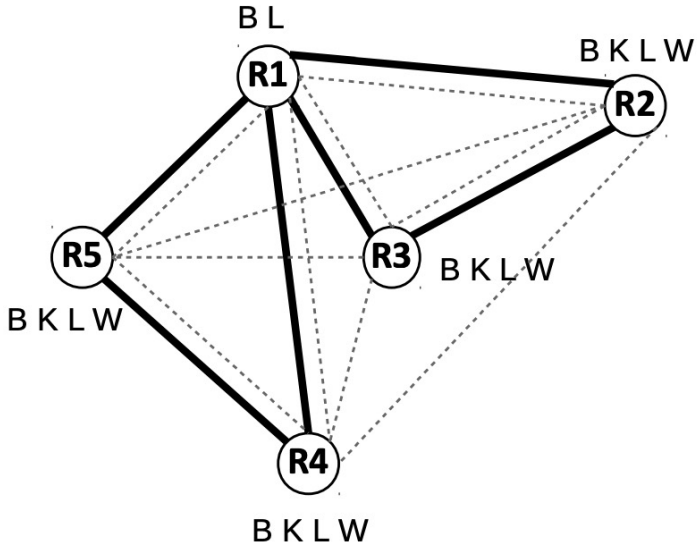


CONSTRAINT SATISFACTION PROBLEM (CSP)



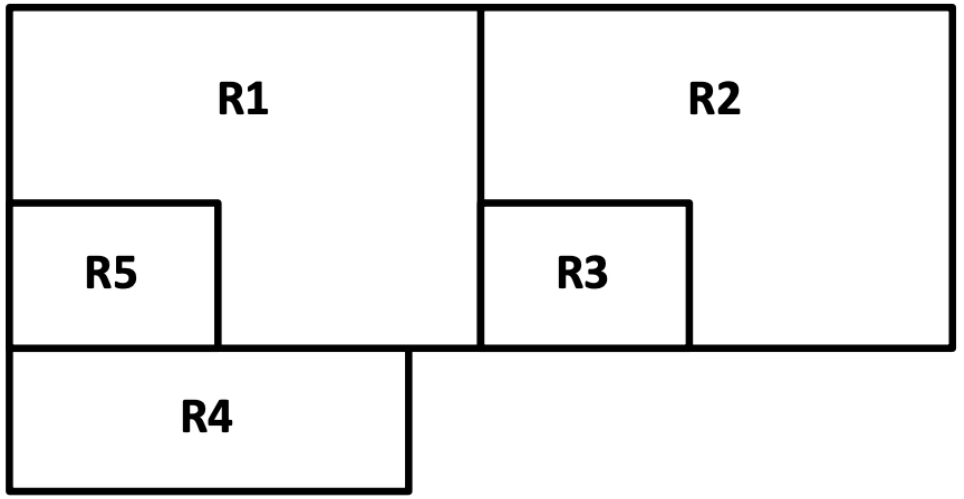
- The requirements are:
- The suite must have exactly 1 Bedroom, 1 Kitchen, 1 Living Room, and 2 Water Closets.
- Room R1 must be either the Bedroom or the Living Room (because that corner of the suite has the best view).
- Adjacent rooms must NOT have the same function, e.g. two adjacent rooms cannot both be Water Closets.

Perform Depth-First Search to find a solution.
Make assignments to rooms in lexicographic order (R1, R2, …). Do NOT reduce domains before search.



CONSTRAINT SATISFACTION PROBLEM (CSP)

Based on the results of your search, write the assigned room funcFon (B, K, L, or W) in each room below, or circle NO SOLUTION if no soluFon was found:



NEURAL NETWORK - BASICS

- You're building a neural net to classify the positive and negative data samples shown below on the left.