AI COURSE TUTORIALS: October 21, 2022

Tutorial on Constraint Satisfaction Problem

Q1. You are in charge of scheduling 5 classes that meet on Mondays, Wednesdays and Thursday. 3 professors will be teaching these classes. You are constrained by the fact that each professor can only teach one class at a time.

The classes are:

1. PDS : time 8.00 AM – 9.00 AM
2. AI : time 8.30 AM to 9.30 AM
3. NLP : time 9.00 AM to 10.00 AM
4. IR : time 9.00 AM to 10.00 AM
5. ML : time 10.30 AM to 11.30 AM

The professors are:

- Professor A, who is available to teach Classes NLP and IR
- Professor B, who is available to teach Classes AI, NLP, IR and ML
- Professor C, who is available to teach Classes PDS, AI, NLP IR and ML.

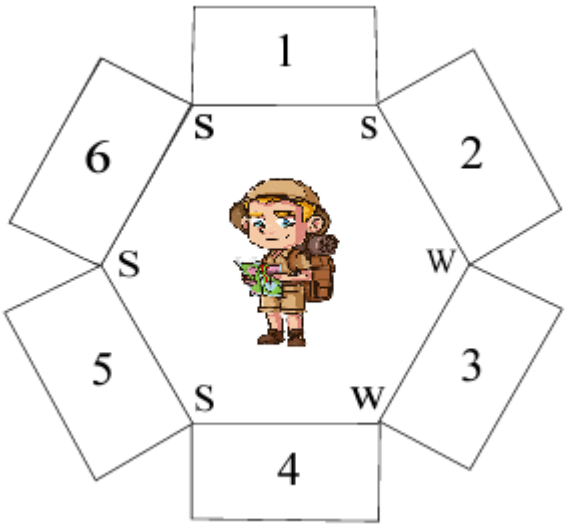
a) Formulate this problem as a CSP problem in which there is one variable per class, stating the domains, and constraints.
b) Draw the constraint graph associated with your CSP. Show the domains of the variables after running arc-consistency on the initial graph (after having enforced any unary constraints).
c) Give the possible solutions for this CSP.

Q2. You are trapped on an island surrounded by mysterious paths, each of which leads to either a pit (P), a ghost (G), or an exit (E). In order to escape, you need to figure out which paths, if any, lead to an exit and freedom, rather than the certain doom of a pit or a ghost.

The one sign of what lies behind the paths is the wind: a pit produces a strong breeze (S) and an exit produces a weak breeze (W), while a ghost doesn't produce any breeze at all. Unfortunately, you cannot measure the strength of the breeze at a specific path. Instead, you can stand between two adjacent paths and feel the max of the two breezes. For example, if you stand between a pit and an exit, you will sense a strong (S) breeze, while if you stand between an exit and a ghost, he will sense a weak (W) breeze. The measurements for all intersections are shown in the figure below.

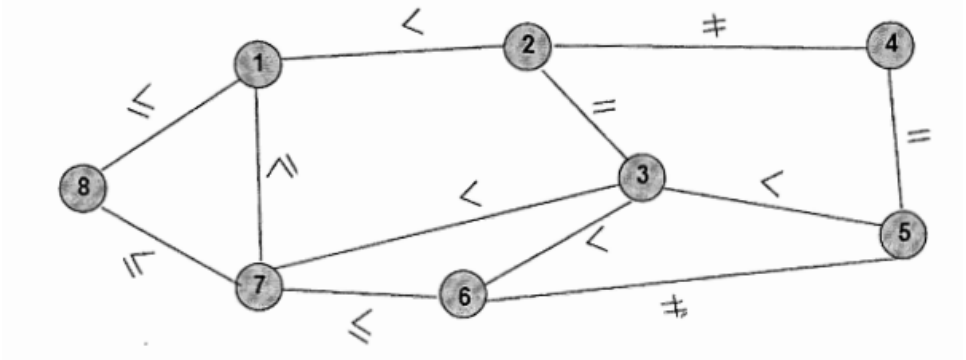
Also, while the total number of exits might be zero, one, or more, you know that two neighboring paths will not both be exits.

Models this problem using variables Xi for each path i and domains P, G, and E.



a) State the binary and/or unary constraints for this CSP.
b) Assume that you know that X6 = G and X2 = G. List all the solutions of this CSP or write none if no solutions exist

Q3. . Consider the following constraint graph. Assume that each variable (node) has a domain of {100, 200, 300, 400}.

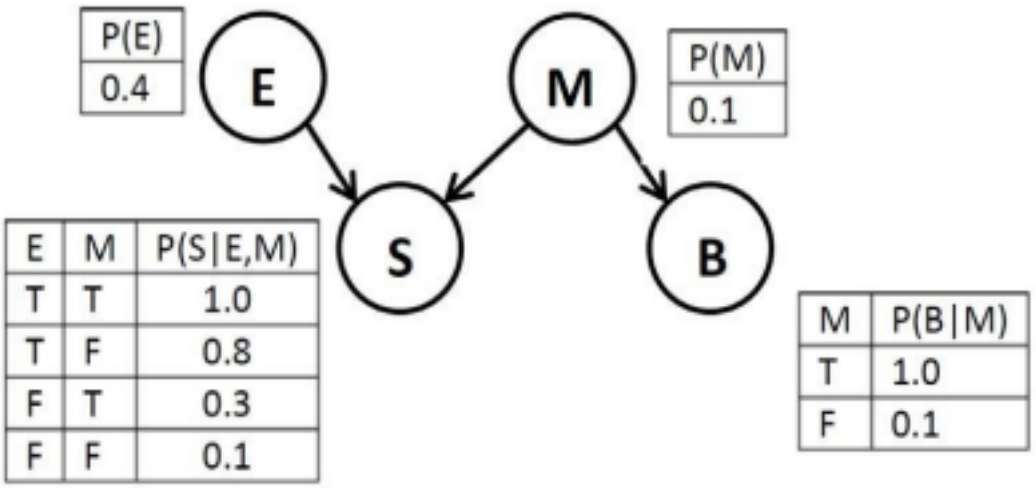


Apply arc consistency to reduce the domains of the variables. Note that, enforcing arc consistency in one edge may result in loss of arc consistency of others. You have to maintain arc consistency of the entire network. Show your steps.

Tutorial on BayesNet

1. A smell of sulfur (S) can be caused either by rotten eggs (E) or as a sign of the doom brought by the Mayan Apocalypse (M). The Mayan Apocalypse also causes the oceans to boil (B).

   The Bayesian network and corresponding conditional probability tables for this situation are shown below.



E	M	P(S|E,M)
T	T	1.0
T	F	0.8
F	T	0.3
F	F	0.1

M	P(B|M)
T	1.0
F	0.1

a. Compute P(E'S'M'B')

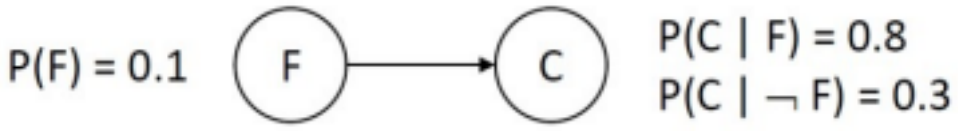
b. What is the probability that the oceans boil?

c. What is the probability that the Mayan Apocalypse is occurring, given that the oceans are boiling?

d. What is the probability that the Mayan Apocalypse is occurring, given that there is a smell of sulfur, the oceans are boiling, and there are rotten eggs? e. What is the probability that rotten eggs are present, given that the Mayan Apocalypse is occurring?

2. Consider the following Bayesian network, where (F = having flu) and (C =coughing) :

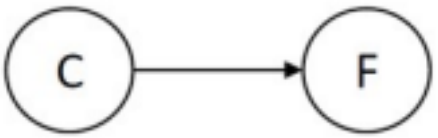
a.



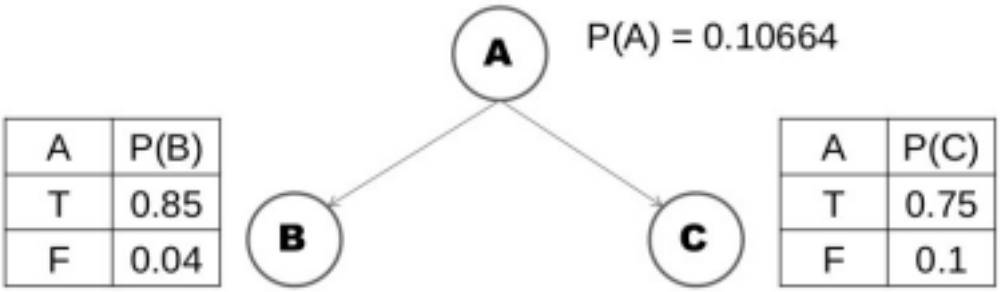
Write down the joint probability table specified by the Bayesian network.

b. Are C and F independent in the Bayesian network of Part a?

c. Determine the probabilities for the alongside Bayesian network so that it specifies the same joint probabilities as above.



3. Consider the following Bayesian network:

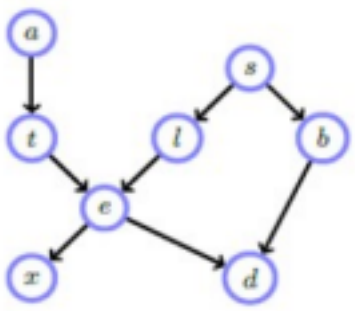


A	P(B)
T	0.85
F	0.04

A	P(C)
T	0.75
F	0.1

Compute P(A | ¬B, C)

4. Examine the following belief network for a Chest Clinic:



x = Positive X-ray
d = Dyspnea (Shortness of breath)
e = Either Tuberculosis or Lung Cancer
t = Tuberculosis
l = Lung Cancer
b = Bronchitis
a = Visited Asia
s = Smoker

The table values are:

P(a) = 0.01 P(s) = 0.5

P(t|a) = 0.05 P(t|¬a) = 0.01

P(l|s) = 0.1 P(l|¬s) = 0.01

P(b|s) = 0.6 P(b|¬s) = 0.3

P(x|e) = 0.98 P(x|¬e) = 0.05

P(d|e,b) = 0.1 P(d|e,¬b) = 0.7

P(d|¬e,b) = 0.8 P(d|¬e,¬b) = 0.1

P(e|t,l) = 0 only if both t and l are false, and 1 otherwise.

Compute P(d)

Tutorial on Planning Graph

1. Suppose you want to prepare dinner as a surprise for your partner (who is asleep)

   Initial Conditions : (garbage ⋀ cleanHands)

   Goal : (dinner ⋀ cleanHands ⋀ ¬garbage)

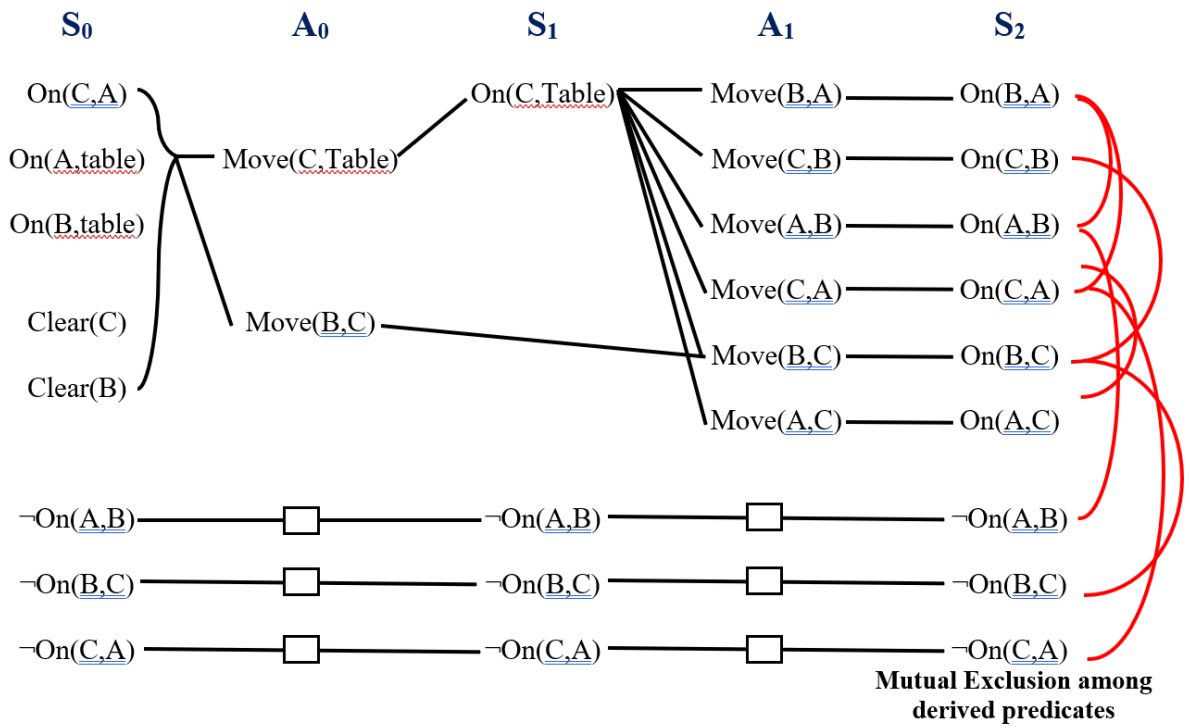
ACTION	**PRECONDITION**	**EFFECT**
Cook	cleanHands	dinner
Wrap	quiet	present
Carry	*none*	¬(garbage)⋀(¬(cleanHands))
Dolly	*none*	¬(garbage)⋀(¬(quiet))

Draw the planning graph after one iteration, clearly indicating all the mutex links.

2. Consider the following planning domain:

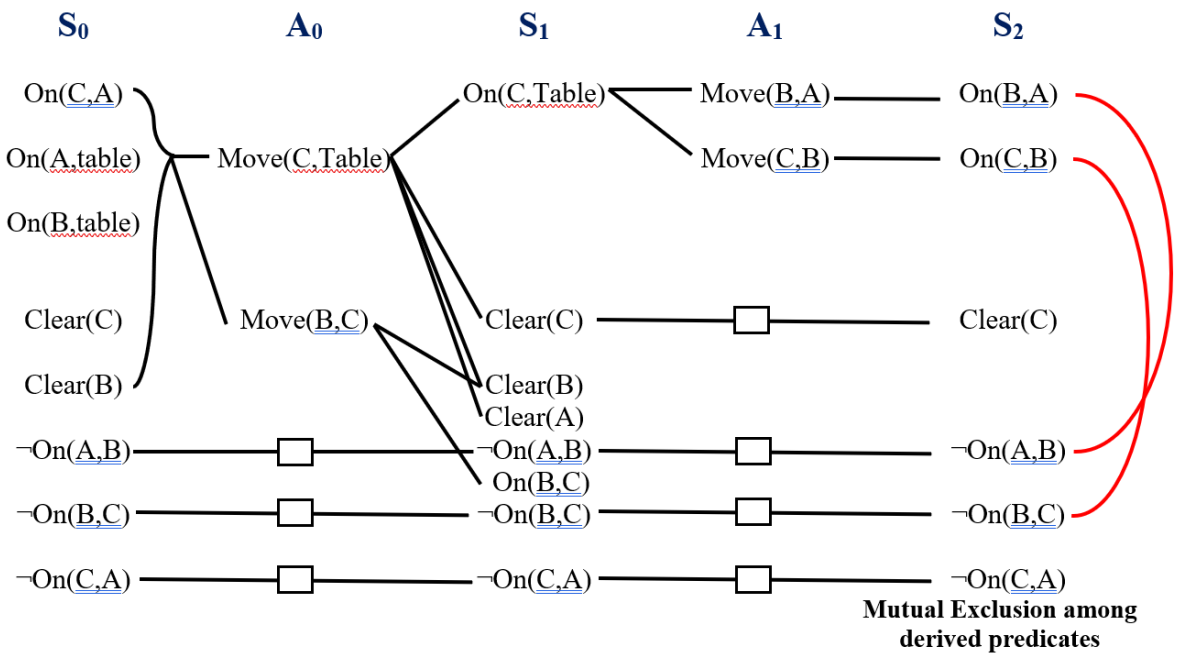
ACTION	**PRECONDITION**	**EFFECT**
Start		dinner
Move(X,Y)	Clear(X), Clear(Y)	On(X, Y))
Move(X, Table)	*Clear(X)*	On(X, Table))
Finish	*On(A, B), On(B, C), On(C, A)*	

Draw the planning graph using the GraphPlan algorithm to determine whether a plan exists. If a plan exists, then the specification of the domain is incomplete. If so, correct the specification and construct the planning graph again.



We can see that the three required conditions of the FINISH are mutually exclusive and all the 3 can not occur simultaneously Eg. If On(B,C), On(A,B), On(A,Table) are required to be fulfilled then On(C,A) can not be satisfied.

We add an EFFECT to the Action: Move(X, Table) as On(X,Table) and Clear(X)



So, we have On(B,A), On(C,B) and clear(C).