ASSIGNMENT 3
BAYESIAN NETWORKS

Team Size

You can do this assignment in teams of 2. Teams are same as that of Assignment-1. You can find your teams here.
http://bit.ly/Assignment-1-teams

Topics

You can pick one of these topics to model your Bayes' net. Your topic number should be ((one of the team members' roll numbers)%15+ 1). Be as realistically creative as you can! :)

1. After the recent terror attacks in Pulwama, terrific outrage created among the citizens of the country. Each citizen had different views on dealing with this situation, some wanted India to declare a war against Pakistan while some wanted to carry out surgical strikes on terrorist organisations , some wanted to carry out peace negotiations while some wanted to ignore this issue and take no action. You being the Prime Minister of the country should take a decision on how to go about considering factors like army strength, defence power, citizens opinion, justice to the martyred CRPF families, after effects etc. Model this as a Bayes network considering all the factors that seem relevant to you, give conditional probabilities and justify.

2. It is a very hectic day with assignment deadlines of AI, DSAA, Graphics and Term Paper all being on the same day and you haven't started any of them till now. After you woke up, you realised that you can only submit 1 assignment and you are not sure which assignment to solve. Model this as a Bayesian network considering factors like pre-requisites of the assignment, resources, how interested you are to solve the assignment, your performance so far in the course(If you have performed very well in mids, you might want to skip the assignment) and other factors that seem relevant to you, give conditional probabilities and justify

3. You are the TA of Artificial Intelligence and you have prepared an assignment on Bayesian networks. You want the hard deadline of assignment to be on April 11th . But however, you know that the students of UG2k17 will ask for an extension, in view of this you decide to keep the assignment deadline 'x' days(x=1/2/3) prior to April 11th. Your job is to model a bayesian network to decide 'x' considering factors like other assignment deadlines, student's work load, exams/quizzes schedules, fests/events, whether the topic was taught in class etc. Give conditional probabilities and justify. (We TAs have solved this problem and found out that P(x=0) is higher given the conditions. Hence this is a hard deadline :D))

4. You woke up and realised that you have an assignment deadline of course 'X' at 11 am which you didn't start and also there is a class of course 'Y' at 10am in which you

have already lost ‘x’(For ex: x=1/2/3/4) classes of attendance. Also, you booked tickets for a movie of your favorite actor. You are in a dilemma whether to attend the class, solve the assignment , go for a movie or forget everything and sleep again. Model a bayesian network considering various factors like mid-1 performance in X and Y, weightage of assignment, how excited you are for the movie etc.Give conditional probabilities and justify.

5. Felicity elections are about to come soon. You suspect there are going to be lot of candidates approaching you for your vote. There are a number of factors you have to consider while selecting your coordinators e.g popularity, ability, support , etc. Model a bayesian network predicting whom you will select based on the above factors. Give conditional probabilities and justify.

6. You are fed up and want to take a break, and luckily you see a small continuous stretch of holidays .You have a few options of spending the holidays - like going home, going to Goa(or any other place), gaming or playing,etc. However you are restricted by multiple factors like money, support from friends (they maybe lazy and want to sleep away the entire day),parents, Hostel LAN, etc. Model a Bayesian network which helps you decide what you would finally do, with conditional probabilities and provide justification for your choices.

7. You are given the responsibility to change the minimum attendance rule of IIIT from 85% to x%. You have to decide considering both the student community as well as the faculty, knowing that if you drop it too low , future consequences for students may be worsened, and if you raise even higher, the students may get mad at you. Consider multiple factors you can think of while deciding this minimum percentage , and model it as a Bayesian net. Give conditional probabilities and justify.

8. New admissions to IIIT are about to begin and having experienced a number of things in IIIT till now (from best to worst), you want to suggest a person whether he/she should join IIIT or not. There are a number of factors affecting this- your view of academics, college life, recognition, satisfaction, conditions in other colleges, etc. Model a Bayesian net to find the chances you will recommend IIIT to an outsider. Give conditional probabilities and justify.

9. You are the producer for a movie and you want to select a new actor/actress for your movie. But you are in a fix since there are many factors you need to decide on like costs, talent, looks, contacts, etc. Also with the criticism on nepotism this has become even harder for you, if he/she should be a new face from the industry or outside. Model a Bayesian net to decide who will play the role in your movie. Give conditional probabilities and justify.

10. After the recent resentment by students of UG2k17 regarding their work load and mental health, Dean (A) has decided to give a short break of ‘x’ days (For ex : x=1/2/3) to the students so that they can refresh themselves and come back stronger. As you are the Dean(A) of IIIT- H, model a Bayes net to find ‘x’ by

considering factors like curriculum balance, faculty's opinion etc. Give conditional probabilities and justify.

11. We all know that Amazon as a company is very successful.Now the CEO of amazon wants to increase his profits.Model a bayesian network with all the factors that have impact on the profit such as AWS,delivery,amazon prime etc and how these factors depend on other sub-factors such as software engineers , number of delivery executives,marketing etc.Give conditional probabilities and justify.

12. Nowadays,we spend most of our time on our mobiles and who doesn't love to have a good mobile? Model a bayesian network to decide which mobile to buy considering factors like brand ,price ,camera quality,gaming etc. Give conditional probabilities and justify.

13. It being IPL season, you have registered yourself for a fantasy league which earns you points if you predict the result of the match correctly. It is the match between CSK and RCB at the chinnaswamy stadium(Banglore). Model a bayesian network predicting who would win the game considering factors like team strength, weather conditions, home ground etc. Give conditional probabilities and justify.

14. You are the coordinator of the UG2k17 batch trip and you want to plan a short trip for around 2-3 days. Planning involves deciding which place to go, what time of the year, how to go etc. Model a Bayes' net that takes into account the factors that affect the planning of a trip, and assign conditional probabilities appropriately.

15. Most of you are currently busy with your honors application. Design a Bayes net modelling the decision process, the net should have an outcome where you don't take honors at all along with outcomes where you take honors in different labs (2 at least).

Structural Constraints

● Your Bayes' net should have 8-16 nodes, and so, you may have to rule out a few factors, and take only the top k factors that you feel are the most significant for your topic.

● There should be a minimum of 3 layers in the net i.e. at least a set of three nodes related to each other and in different layers. A 4/5 layer network is advised. In other words, nodes in such types of nets tend to have in the range of 2-5 parent nodes. You need to take into consideration the fact that your CPT should be neither too small nor too big.

● If you feel that the number of dependencies is very high, you could prune some of them with an appropriate justification for the same. (However, this does not imply that you can do the same to make an easy net and evade calculations. :))

● If there are too many rows in a Conditional Probability Table (CPT), try to remove the less significant ones. A CPT with 40 rows is considered big enough, for most of the cases we have provided, and so feel free to prune the rest of it, but do give a justification for the same. Note that your CPTs may be much smaller or slightly larger than this. They should always contain

enough information to model reality to a good extent, and abstract out details, which you feel are unnecessary, and make

Submission Guidelines

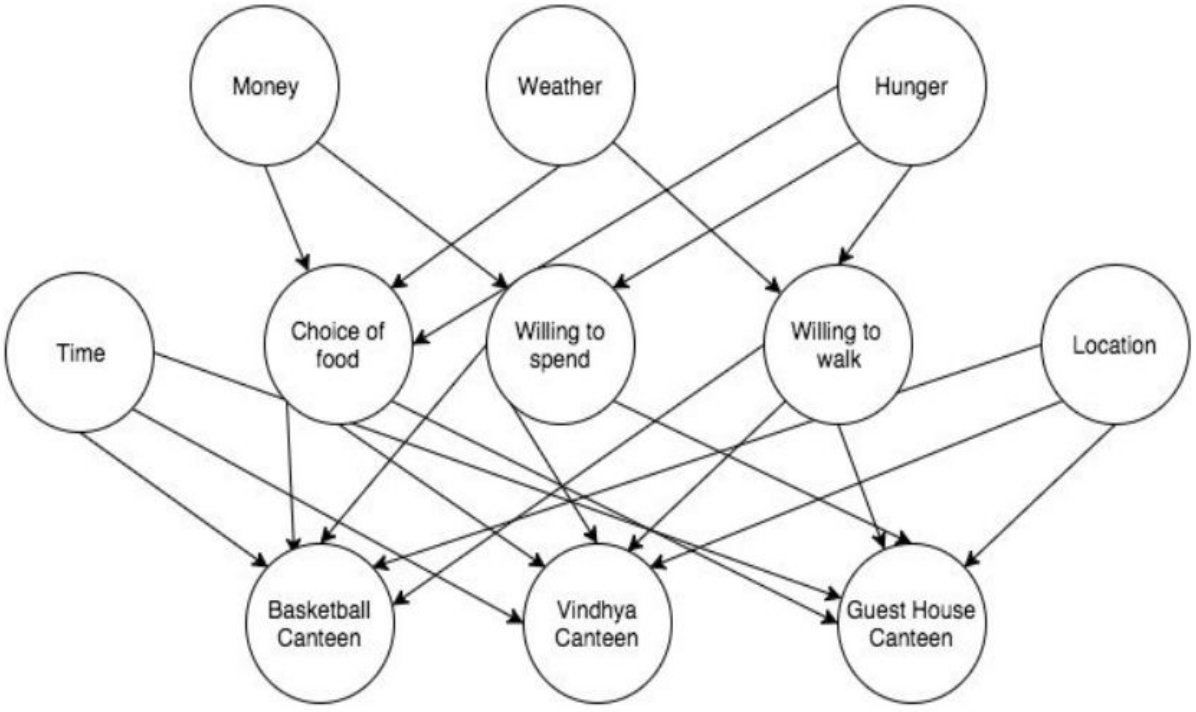
You are required to submit the following in a single pdf file:

1. A diagram of the Bayes' net
2. Conditional Probability Tables for all dependencies
3. A justification behind the reasons for your choosing different probabilities for different nodes.
4. A solved query (you have to pick one yourself) following the guidelines mentioned later in the assignment.
5. Name of the file should be Team<Team_No>_<RollNum1>_<Rollnum2>.pdf

Example problem

You are hungry and want to have a quick snack, or a meal, or a glass of juice. How do you decide which canteen to choose? (Assuming you don't want to eat in the mess!!)

Solution:



Given above is the diagram of the Bayes' net that we have developed, to give you an idea of the level of detail you need to go to in order to model a net.

Key:

T	Time	1:00-8:00, 8:00-10:00,10:00-20:00, 20:00-1:00
M	Money	Afford, Can not afford
W	Weather	Sunny, Rainy, Other
H	Hunger	High, Low
L	Location	OBH, Parul, Himalaya/Vindhya
CF	Choice of Food	Snacks, Beverage, Meal
WS	Willing to Spend	High, Low
WW	Willing to Walk	High, Low
BB	Basketball Canteen	Yes, No
VC	Vindhya Canteen	Yes, No
GH	Guest House Canteen	Yes, No

Conditional Probability Tables:

Time:

T	1:00-8:00	8:00-10:00	10:00-20:00	20:00-1:00
P(T)	0.2	0.05	0.45	0.3

Money:

M	Afford	Not
P(M)	0.5	0.5

Weather:

W	Sunny	Rainy	Other
P(W)	0.5	0.2	0.3

Hunger:

H	Low	High
P(H)	0.5	0.5

Location:

L	OBH	Parul	Himalaya/Vindhya
P(L)	0.6	0.15	0.25

Choice of Food:

H	M	W	CF.Snack	CF.Beverage	CF.Meal
High	Afford	Sunny	0.1	0.4	0.5
High	Afford	Rainy	0.3	0.1	0.6
High	Afford	Other	0.25	0.25	0.5
High	Not	Sunny	0.3	0.6	0.1
High	Not	Rainy	0.6	0.3	0.1
High	Not	Other	0.5	0.4	0.1
Low	Afford	Sunny	0.3	0.7	0
Low	Afford	Rainy	0.7	0.3	0
Low	Afford	Other	0.5	0.5	0
Low	Not	Sunny	0.2	0.8	0
Low	Not	Rainy	0.8	0.2	0
Low	Not	Other	0.4	0.6	0

Willingness to spend:

M	H	WS.Low	WS.High
Afford	Low	0.8	0.2
Afford	High	0.2	0.8
Not	Low	0.9	0.1
Not	High	0.7	0.3

Willingness to walk:

W	H	WW.Low	WW.High
Sunny	Low	0.9	0.1
Sunny	High	0.6	0.4
Rainy	Low	1	0
Rainy	High	0.5	0.5
Other	Low	0.5	0.5
Other	High	0.3	0.7

Basketball Canteen:

T	CF	WS	WW	L	P(Yes)
10:00-20:00	Snack	Low	Low	Parul	0.6
10:00-20:00	Snack	Low	Low	OBH	0.2
10:00-20:00	Snack	Low	Low	Himalaya	0.2
10:00-20:00	Snack	Low	High	Parul	0.6
10:00-20:00	Snack	Low	High	OBH	0.4
10:00-20:00	Snack	Low	High	Himalaya	0.4
10:00-20:00	Snack	High	Low	Parul	0.9
10:00-20:00	Snack	High	Low	OBH	0.3
10:00-20:00	Snack	High	Low	Himalaya	0.3
10:00-20:00	Snack	High	High	Parul	0.9
10:00-20:00	Snack	High	High	OBH	0.9
10:00-20:00	Snack	High	High	Himalaya	0.9
10:00-20:00	Beverage	Low	Low	Parul	0.3
10:00-20:00	Beverage	Low	Low	OBH	0.05
10:00-20:00	Beverage	Low	Low	Himalaya	0.05

10:00-20:00	Beverage	Low	High	Parul	0.3
10:00-20:00	Beverage	Low	High	OBH	0.1
10:00-20:00	Beverage	Low	High	Himalaya	0.1
10:00-20:00	Beverage	High	Low	Parul	0.45
10:00-20:00	Beverage	High	Low	OBH	0.05
10:00-20:00	Beverage	High	Low	Himalaya	0.05
10:00-20:00	Beverage	High	High	Parul	0.45
10:00-20:00	Beverage	High	High	OBH	0.1
10:00-20:00	Beverage	High	High	Himalaya	0.1

Vindhya Canteen:

T	CF	WS	WW	L	P(Yes)
8:00-20:00	Snack	Low	Low	Parul	0.1
8:00-20:00	Snack	Low	Low	OBH	0.1
8:00-20:00	Snack	Low	Low	Himalaya	0.4
8:00-20:00	Snack	Low	High	Parul	0.2
8:00-20:00	Snack	Low	High	OBH	0.2
8:00-20:00	Snack	Low	High	Himalaya	0.4
8:00-20:00	Snack	High	Low	Parul	0.2
8:00-20:00	Snack	High	Low	OBH	0.2
8:00-20:00	Snack	High	Low	Himalaya	0.9
8:00-20:00	Snack	High	High	Parul	0.3
8:00-20:00	Snack	High	High	OBH	0.3
8:00-20:00	Snack	High	High	Himalaya	0.9
8:00-20:00	Beverage	Low	Low	Parul	0.1
8:00-20:00	Beverage	Low	Low	OBH	0.1
8:00-20:00	Beverage	Low	Low	Himalaya	0.4

8:00-20:00	Beverage	Low	High	Parul	0.2
8:00-20:00	Beverage	Low	High	OBH	0.2
8:00-20:00	Beverage	Low	High	Himalaya	0.4
8:00-20:00	Beverage	High	Low	Parul	0.2
8:00-20:00	Beverage	High	Low	OBH	0.2
8:00-20:00	Beverage	High	Low	Himalaya	0.9
8:00-20:00	Beverage	High	High	Parul	0.3
8:00-20:00	Beverage	High	High	OBH	0.3
8:00-20:00	Beverage	High	High	Himalaya	0.9

Guesthouse Canteen:

T	CF	WS	WW	L	P(Yes)
12:00-1:00	Snack	Low	Low	Parul	0.1
12:00-1:00	Snack	Low	Low	OBH	0.7
12:00-1:00	Snack	Low	Low	Himalaya	0.1
12:00-1:00	Snack	Low	High	Parul	0.2
12:00-1:00	Snack	Low	High	OBH	0.7
12:00-1:00	Snack	Low	High	Himalaya	0.2
12:00-1:00	Snack	High	Low	Parul	0.1
12:00-1:00	Snack	High	Low	OBH	0.8
12:00-1:00	Snack	High	Low	Himalaya	0.1
12:00-1:00	Snack	High	High	Parul	0.8
12:00-1:00	Snack	High	High	OBH	0.9
12:00-1:00	Snack	High	High	Himalaya	0.8
12:00-1:00	Beverage	Low/High	Low	Parul	0.2
12:00-1:00	Beverage	Low/High	Low	OBH	0.6
12:00-1:00	Beverage	Low/High	Low	Himalaya	0.2
12:00-1:00	Beverage	Low/High	High	Parul	0.6

12:00-1:00	Beverage	Low/High	High	OBH	1
12:00-1:00	Beverage	Low/High	High	Himalaya	0.6
12:00-1:00	Meal	Low	Low	Parul	0.05
12:00-1:00	Meal	Low	Low	OBH	0.15
12:00-1:00	Meal	Low	Low	Himalaya	0.05
12:00-1:00	Meal	Low	High	Parul	0.15
12:00-1:00	Meal	Low	High	OBH	0.3
12:00-1:00	Meal	Low	High	Himalaya	0.15
12:00-1:00	Meal	High	Low	Parul	0.4
12:00-1:00	Meal	High	Low	OBH	0.8
12:00-1:00	Meal	High	Low	Himalaya	0.4
12:00-1:00	Meal	High	High	Parul	0.9
12:00-1:00	Meal	High	High	OBH	1
12:00-1:00	Meal	High	High	Himalaya	0.9

Justifications:

1. Vindhya canteen and basketball canteen serve only beverages, and snacks. Hence, the probability of you going to one of these for a meal would be zero.

2. Snacks and beverages are not very expensive, and as a result, low willingness to spend would not greatly impact the final decision made.

3. Quality and taste of the food served in a particular canteen, along with its popularity, have also been taken into consideration. For example, the snacks at Vindhya canteen and Basketball canteen are considered to be better than those at the Guest House canteen and so, the probabilities are higher for these.

4. For hostels which are close to the respective canteens, the willingness to walk is not a very significant factor. For example, Parul hostel is closer to the Basketball canteen, so the willingness to walk will not affect the decision to go and eat there.

5. Willingness to walk depends to a great extent on the weather. If the weather is rainy, one would probably not want to walk a greater distance to have a snack or a beverage.

Query Structure:

Pick any 1 of the following:

- P(X | p(X), p(p(X)))
- P(p(p(X)) | X)
- P(p(X) | X, p(p(X)))

where p(X) refers to the parent of X.

<u>Sample Query:</u>

- P(Vindhya=Yes | CF=Beverage, Weather=Sunny) ~ 0.15