Assignment 3
Bayes' Nets

Team Size

This assignment should be done in teams of 2.

Topics

Your topic number should be ((one of the team members' roll numbers)%15 + 1). Be as realistically creative as you can! :)

1) Autonomous Driving System

It's hard to decide speed for the system.One good way to solve this problem is to estimate the correct speed based on the various road and traffic parameters at that time.
Since safety is always a priority, system should never go too fast just because the road is empty.
The system should decide the right speed based on the weather and the surroundings.Model the speed's choice as a Bayes net problem and keep in mind the points like the weather,Tire condition etc. Also assign conditional probabilities.

2) Cricket Victory Prediction

People have various discussions on which team would end up on the winning side. Your job is to come with a Bayesian net that involves some of the factors that would be essential for deciding on which team is more likely to win the match. You would want to predict who would win the game taking some factors into consideration like home ground, etc. formulating a Bayes' net, and assigning probabilities.

3) Which Movie to watch

You would want to watch a movie in a theater with your loved one. But you are not sure which movie to watch. So, considering the different factors like the distance of the theater, the movie rating etc. you need to decide using a Bayes' net(choose the best movie to impress your date), and add conditional probabilities for the same and justify the distribution.

4) Transport

You what to know which transport is best to choose from Metro, bus, cab, bike etc to go to some place based on various factors traffic, price etc and also give conditional probabilities for the same, and justify the distribution.

5) Buying a Car

There are numerous things that should be thought of for choosing a car. Your job is to model this into a Bayesian net, involving all possible things that should to thought of to buy a car ex-: typical weather,road type, type of rides etc and give conditional probabilities for the same, and justify the distribution .

6) Elections

Most of us have taken part in, or at least witnessed, the election of choosing our representatives. This(elections) domain involves a scientific analysis of numerous factors that play minor or major roles in elections, such as candidate popularity, linguistic, regional, and similar such factors, to give a fairly accurate prediction of the results of the election. You are expected to take into account all such factors that seem relevant to you, and model a Bayes' net, along with the conditional probabilities, and justify the same. Be a political pundit! :)

7) iPhoneXI Sales Prediction:

As most of us know, Apple is always about building "passionate products that influence millions of beings"and one of their signature product is the iPhone. As you're the CEO of the company, you decide to launch iPhone XI(since Pixel II was better than iPhone X).
Most businesses are oriented towards increasing their sales, be it a product or a service. Since these sales are so critical, it is a good idea to predict how much revenue a company will generate. You must have seen business sales predictions which are quarterly based.

For example, you could refer to the following links

http://arstechnica.com/apple/2016/01/apples-q2-revenue-forecast-overshadows-a-record-breaking-q1-of-2016/
http://9to5mac.com/2016/01/26/apple-earnings-fy16-q1/

You have to do something similar. Your problem is to analyse what factors affect these sales and consequently convert your findings in a Bayes net with conditional probability tables. A factor could be demand, which in turn depends on price, competition etc.

8) Housing Market

Housing market is one of the best known prediction problems. With so many factors affecting it, you never know what will become more valuable and what depreciates. The lack of informations adds to the difficulty of predicting housing prices. You have to consider various such factors while modelling this as a Bayes net. Obviously we don't expect you to incorporate all(possibly 1000s) factors, but it is expected that you'll take in most major factors and will be able to justify them.

9) TV Series - Hit or not

Most of like to watch TV series like Friends, GOT. A lot of times it so happens that they don't do as well as we expect them to. Wouldn't it be nice to have an algorithm that can tell how good a TV series will be?

You have to design something for this case. Model the predicted success of a movie using a Bayes net. Along with very common factors like cast and plot of the TV series, try to incorporate not-so-visible factors like number and genre of hit TV series just before this one, among others.

10) Why not MIT?

You might have experienced a lot of hustle while deciding on the college(finally IIIT! :P). All the information and analysis you carried to decide the best one you can get. So now, design a bayes net to provide you the best one of all available choices. Include all the options you had, all the factors you considered. You might as well include your interests (branch preference).

11) Movie this Weekend

You have been meaning to watch a movie for a while now, and it turns out you will be entirely free after this AI assignment :P. Design a bayes net that will help you decide your movie plans. You can watch the movie on your laptop or the cinema hall. Also consider all other factors such as rating, the cast, popularity, friends recommendation etc. You don’t have to mention the movies’ titles explicitly..The bayes net decides the best movie you should consider watching.

12) Selective Electives

Selecting electives in your third year can be tough and confusing especially since you need to consider a variety of factors before you make your final decision. So let us try and automate the process using a Bayes Net.

Keep in mind that the Institute has special restrictions (based on branch etc) on some courses and find out other factors you will need to consider before you select a course. Also factor in your personal interests and preferences while designing the Bayes net on whether or not to take an elective.

You can refer to https://www.iiit.ac.in/academics/curriculum/undergraduate/cse/ for details.

13) To Honors or not to Honors?

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).

14)Farmer's Dilemma

You are a farmer in Telangana who simply loves groundnuts. However growing groundnuts just because you like to eat them is probably not a very good idea. Hence you need to consider other options as well. Design a bayes net for the choice of the most favourable crop to grow.
Remember that the growing of a crop at a particular time of a year is subject to various factors - the weather/climate conditions, type of crop, the demand for that crop, cost for various fertilizers and pesticides, transportation, etc.

You are recommended but not limited to use this link:
http://www.cropsreview.com/crop-selection.html

15)Textile production

You are the product manager of factory involved in textile production. Production of a textile in a factory is dependent on several factors - like user base, demand, supply, labour costs, manufacturing costs, utility of the clothing item being produced, transportation costs, etc.
Imagine you are the Production Manager of a leading factory.
Design a bayes net for the production of a textile(s) of your choice.

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:

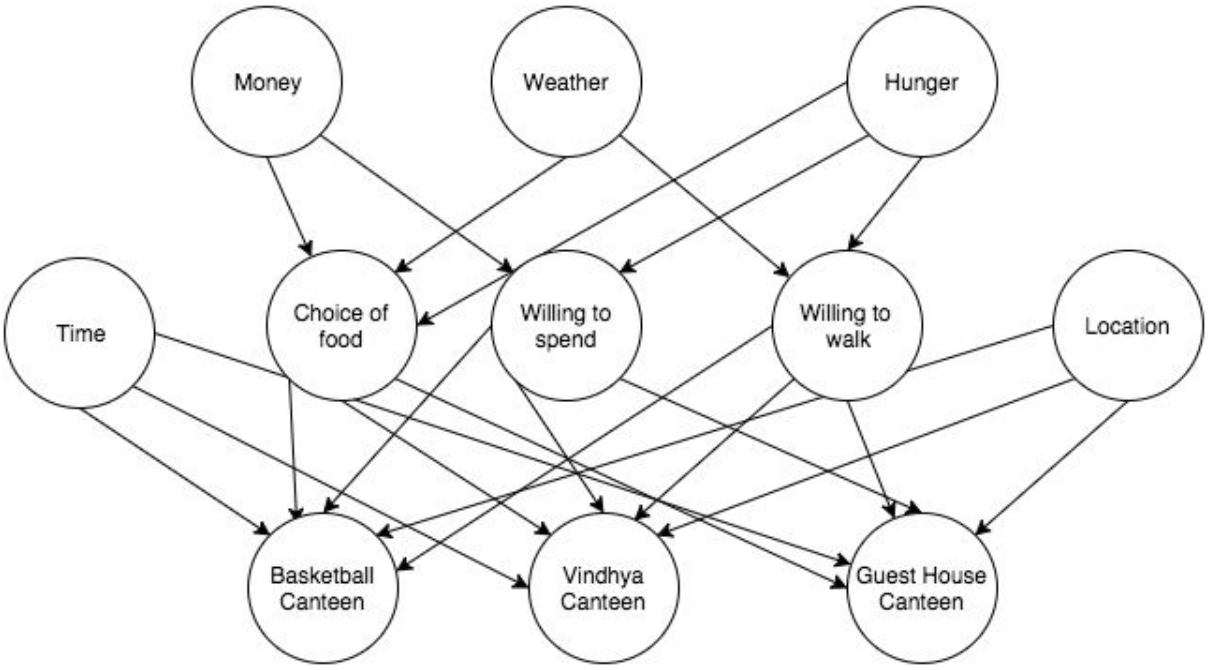
1. A diagram of the Bayes' net
2. Conditional Probability Tables for all dependencies
3. A justification behind the reasons for your choosing different probabilities for different nodes.
4. A solved query (you have to pick one yourself) following the guidelines mentioned later in the assignment.

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:

The following 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

Guest House 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 out of these.)

- 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.

Sample Query:

- P(Vindhya=Yes | CF=Beverage, Weather=Sunny) = 0.131875