

Program-7

Construct a bayesian network using medical dataset. Use this model to demonstrate the diagnosis of heart patient using standard heart disease data.

```
Program-7

import numpy as np
import pandas as pd
import csv
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination

lines = list(csv.reader(open('data7.names.csv', 'r')))
attributes = lines[0]
print(lines)

heartDisease = pd.read_csv('data7.heart.csv', names=attributes)
heartDisease = heartDisease.replace('?', np.nan)
print('Few examples from the dataset are given below')
print(heartDisease.head())

model = BayesianModel([('age', 'trestbps'), ('age', 'fbs'), ('sex', 'trestbps'), ('exang', 'trestbps'), ('trestbps', 'heartdisease'), ('fbs', 'heartdisease'), ('heartdisease', 'restecg'), ('heartdisease', 'thal'), ('heartdisease', 'chol')])

import networkx as nx
import pylab as plt
nx.draw(model, with_labels=True)
plt.show()

model.local_independencies('trestbps')
model.local_independencies('age')
model.get_independencies()

print(model.get_cpds('age'))
```

```

print(model.get_cpds('thal'))
print(model.get_cpds('chol'))
print('Inferencing with Bayesian Network:')
HeartDisease_infer = VariableElimination(model)

```

```

print('1. Probability of HeartDisease given Age=44')
q = HeartDisease_infer.query(variables=['heartdisease'], evidence
                              = {'age': 44, 'chol': 15})
print(q)

```

CPT values calculation

Total rows with heart disease(0) = 164

* For thal

* For thal (for 3)

Rows with thal 3 & heart disease(0) = 129

$$\therefore \frac{129}{164} = 0.7865$$

No. of rows with thal 3 & heart disease(1) = 22

Total no. of rows with heart disease(1) = 55

$$\therefore \frac{22}{55} = 0.4$$

(for 6)

Rows with thal 6 & heart disease(0) = 6

$$\therefore \frac{6}{164} = 0.3658$$

Rows with thal 6 & heart disease(1) = 3

$$\therefore \frac{3}{55} = 0.0545$$

* For chol

Rows with chol(126) and heart disease(0) = 1

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$$\therefore \frac{1}{164} = 0.006097$$

Rows with chol(211) & heart disease(0) = 4

$$\therefore \frac{4}{164} = 0.02439$$

OUTPUT

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```
In [3]: import numpy as np
import pandas as pd
import csv
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination

In [5]: #Read the attributes
lines = list(csv.reader(open('data7_names.csv', 'r')))
attributes = lines[0]
print(lines)

[['age', 'sex', 'cp', 'trestbps', 'chol', 'fbs', 'restecg', 'thalach', 'exang', 'oldpeak', 'slope', 'ca', 'thal', 'heartdisease']]

In [6]: heartDisease = pd.read_csv('data7_heart.csv', names = attributes)
heartDisease = heartDisease.replace('?', np.nan)

print('Few examples from the dataset are given below')
print(heartDisease.head())
```

Few examples from the dataset are given below

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	\
0	63	1	1	145	233	1	2	150	0	2.3	3	
1	67	1	4	160	286	0	2	108	1	1.5	2	
2	67	1	4	120	229	0	2	129	1	2.6	2	
3	37	1	3	130	250	0	0	187	0	3.5	3	
4	41	0	2	130	204	0	2	172	0	1.4	1	

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```
print('Few examples from the dataset are given below')
print(heartDisease.head())

Few examples from the dataset are given below
age sex cp trestbps chol fbs restecg thalach exang oldpeak slope \
0 63 1 1 145 233 1 2 150 0 2.3 3
1 67 1 4 160 286 0 2 108 1 1.5 2
2 67 1 4 120 229 0 2 129 1 2.6 2
3 37 1 3 130 250 0 0 187 0 3.5 3
4 41 0 2 130 204 0 2 172 0 1.4 1

ca thal heartdisease
0 0 6 0
1 3 3 2
2 2 7 1
3 0 3 0
4 0 3 0

In [7]: # Model Bayesian Network
model = BayesianModel([('age', 'trestbps'), ('age', 'fbs'), ('sex', 'trestbps'), ('exang', 'trestbps'), ('trestbps', 'heartdisease'), ('heartdisease', 'restecg'), ('heartdisease', 'thal'), ('heartdisease', 'chol')])

In [8]: import networkx as nx
import pylab as plt
nx.draw(model, with_labels=True)
plt.show()
```

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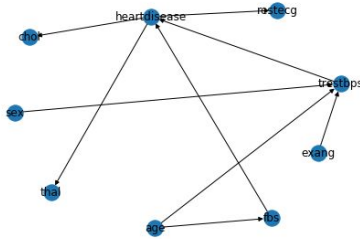
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Run Code



```
In [9]: model.local_independencies('trestbps')
model.local_independencies('age')
model.get_independencies()
```

```
Out[9]: (age _|_ sex, exang)
(age _|_ exang | sex)
(age _|_ sex, exang | fbs)
(age _|_ sex | exang)
(age _|_ restecg, thal, chol | heartdisease)
(age _|_ exang | sex, fbs)
(age _|_ restecg, thal, chol | sex, heartdisease)
(age _|_ heartdisease, restecg, thal, chol | trestbps, fbs)
(age _|_ sex | fbs, exang)
```

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Out[9]:

```
(age | sex, exang)
(age | exang | sex)
(age | sex, exang | fbs)
(age | sex | exang)
(age | restecg, thal, chol | heartdisease)
(age | exang | sex, fbs)
(age | restecg, thal, chol | sex, heartdisease)
(age | heartdisease, restecg, thal, chol | trestbps, fbs)
(age | sex | fbs, exang)
(age | restecg, thal, chol | fbs, heartdisease)
(age | thal, chol | restecg, heartdisease)
(age | restecg, thal, chol | trestbps, heartdisease)
(age | restecg, thal, chol | exang, heartdisease)
(age | restecg, thal | heartdisease, chol)
(age | restecg, chol | thal, heartdisease)
(age | heartdisease, restecg, thal, chol | sex, trestbps, fbs)
(age | restecg, thal, chol | sex, fbs, heartdisease)
(age | thal, chol | sex, restecg, heartdisease)
(age | restecg, thal, chol | sex, trestbps, heartdisease)
```

In [10]: # Learning CPDs using Maximum Likelihood Estimators

```
print('\nLearning CPDs using Maximum Likelihood Estimators...');
print(model.fit(heartDisease))
```

Learning CPDs using Maximum Likelihood Estimators...
None

In [11]:

```
print(model.get_cpds('age'))
print(model.get_cpds('thal'))
print(model.get_cpds('chol'))
```

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```
print(model.get_cpds('age'))
print(model.get_cpds('thal'))
print(model.get_cpds('chol'))
```

```
+-----+
| age(29) | 0.003367 |
+-----+
| age(34) | 0.00673401 |
+-----+
| age(35) | 0.013468 |
+-----+
| age(37) | 0.00673401 |
+-----+
| age(38) | 0.003367 |
+-----+
| age(39) | 0.013468 |
+-----+
| age(40) | 0.010101 |
+-----+
| age(41) | 0.03367 |
+-----+
| age(42) | 0.026936 |
+-----+
```

In [12]: # Inferencing with Bayesian Network

```
print('\nInferencing with Bayesian Network:')
HeartDisease_infer = VariableElimination(model)
```

Inferencing with Bayesian Network:

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None

```
In [11]: print(model.get_cpds('age'))
print(model.get_cpds('thal'))
print(model.get_cpds('chol'))
```

heartdisease	heartdisease(0)	heartdisease(1)	heartdisease(2)	heartdisease(3)	heartdisease(4)
thal(3)	0.79375	0.4074074074074074	0.2	0.17142857142857143	0.15384615384615385
thal(6)	0.0375	0.05555555555555555	0.17142857142857143	0.02857142857142857	0.15384615384615385
thal(7)	0.16875	0.5370370370370371	0.6285714285714286	0.8	0.6923076923076923

```
In [12]: # Inferencing with Bayesian Network
print('\nInferencing with Bayesian Network:')
```

heart failure bbn.py heart_failure.csv ~.....csv Show all

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None

```
In [11]: print(model.get_cpds('age'))
print(model.get_cpds('thal'))
print(model.get_cpds('chol'))
```

chol(126)	chol(131)	chol(141)	chol(149)
0.00625	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.00625	0.0	0.0	0.0
0.00625	0.018518518518518517	0.0	0.0

```
In [12]: # Inferencing with Bayesian Network
print('\nInferencing with Bayesian Network:')
```

chol(342)	chol(353)	chol(354)	chol(360)	chol(394)	chol(407)	chol(409)	chol(417)	chol(564)
0.00625	0.0	0.00625	0.00625	0.00625	0.0	0.0	0.00625	0.00625
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00625	0.0	0.00625	0.0	0.00625	0.0	0.0	0.0	0.0
0.00625	0.0	0.00625	0.0	0.0	0.0	0.0	0.0	0.0
0.00625	0.0	0.00625	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00625	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00625	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
In [12]: # Inferencing with Bayesian Network
print('\nInferencing with Bayesian Network:')
```

heart failure bbn.py heart_failure.csv ~.....csv Show all

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In [13]: `# Computing the probability
print('\n1.Probability of HeartDisease given Age=44')
q = HeartDisease_infer.query(variables=['heartdisease'],evidence={'age':10,'chol':15})
print(q)`

C:\Users\rajes\anaconda3\lib\site-packages\pgmpy\factors\discrete\DiscreteFactor.py:439: UserWarning: Found unknown state name.
Trying to switch to using all state names as state numbers
"Found unknown state name. Trying to switch to using all state names as state numbers"
Finding Elimination Order: : 0% | 0/6 [00:00<?, ?it/s]

1.Probability of HeartDisease given Age=44

Finding Elimination Order: : 100% | 6/6 [00:00<00:00, 1201.35it/s]
Eliminating: thal: 100% | 6/6 [00:00<00:00, 193.87it/s]

heartdisease	phi(heartdisease)
heartdisease(0)	0.5882
heartdisease(1)	0.0000
heartdisease(2)	0.2160
heartdisease(3)	0.1950
heartdisease(4)	0.0000

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