	Smt. Indira Gandhi College of Engineering Ghansoli – Navi Mumbai Computer Engineering Department Academic Year 2022-23 (Even Sem)

Student Name: Sanket Phadtare **Roll No:** 71 **Class:** TE **Sem:** VI

Course Name: Artificial Intelligence Lab

Course Code: CSL604

Experiment No. 08

Experiment Title: IMPLEMENTING BAYESIAN NETWORK : BURGLARY ALARM PROBLEM

<table>
<tr><th rowspan="3">Date of Performance</th><th rowspan="3">Date of Submission</th><th colspan="5">Marks (10)</th><th rowspan="3">Sign / Remark</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
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A: On Time Submission **B:** Understanding **C:** Analytical Skill

D: Critical Thinking **E:** Presentation

Sanket Phadtare
71

Date:

Date	Experiment No - 08	Signature
	Title : Implementing Bayesian Network : BURGLARY ALARM PROBLEM	

Aim : WAP to Implement Bayesian Network : BURGLARY ALARM PROBLEM

Theory :

Example : Harry installed a new burglar alarm at his home to detect burglary. The alarm reliably responds at detecting a burglary but also responds for minor earthquakes. Harry has two neighbors David and sophia, who have taken a responsibility to inform Harry at work when they hear the alarm. David always calls harry when he hears the alarm, but sometimes he got confused with the phone ringing and calls at that time too. On the other hand, sophia likes to listen to high music. So, sometimes she misses to hear the alarm. Here we would to compute the probability of Burglary Alarm.

Problem : Calculate the probability that probability that alarm has sounded, but their is neither a burglary, nor an earthquake occured, and David and Sophia both called the Harry.

Date:

Solution :

- The Bayesian network for the above problem is given below. The network structure is showing the burglary and earthquake is the parent node of the alarm and directly affecting the probability of alarm's going off, but David and Sophia's calls depend on alarm probability.
- The network is representing that our assumptions do not directly perceive the burglary and also do not notice the minor earthquake, and they also not confer before calling.
- The conditionals distributions for each node are given as conditional probabilities table or CPT.
- Each row in the CPT must be sum to 1 because all the entries in the table represents an exhaustive set of cases for the variable.
- In CPT, a boolean variable with k boolean parents contain 2^k probabilities. Hence, if there are two parents, then CPT will contain 4 probability values.

List of all events occuring in this network :

- Burglary (B)
- Earthquake (E)
- Alarm (A)
- David Calls (D)
- Sophia Calls (S)

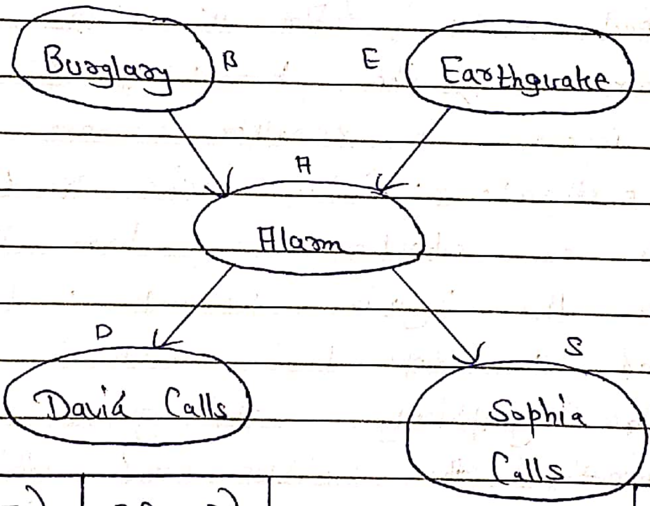
Date:

We can write the events of problem statement in the form of probability : P [D, S, A, B, E], Can rewrite the above probability statement using joint probability distribution.

P [D, S, A, B, E] = P [D| S, A, B, E] . P [S, A, B, E]
= P [D| S, A, B, E] . P [S| A, B, E] . P [A, B, E]
= P [D| A] . P [S| A, B, E] . P [A, B, E]
= P [D| A] . P [S| A] . P [A| B, E] . P [B, E]
= P [D| A] . P [S| A] . P [A| B, E] . P [B| E] . P [E]

T	0·002
F	0·958

T	0·001
F	0·999



A	P(D=T)	P(D=F)
T	0·91	0·09
F	0·05	0·95

A	P(S=T)	P(S=F)
T	0·75	0·25
F	0·02	0·98

B	E	P(A=T)	P(A=F)
T	T	0·94	0·06
T	F	0·95	0·04
F	T	0·59	0·69
F	F	0·999	0·999

Date:

- **Algorithm :**

- Identify the variables : Identify the variables that are relevant to the problem. In this case, the variables are burglary, earthquake, Alarm, ~~John~~ David Calls, and Sophia Calls.
- Define the relationships : Identify the casual relationships between the variables. For example, the occurence of a burglary or an earthquake can cause the alarm to go off. ~~John~~ David & ~~mary~~ Sophia might call if they hear the alarm.
- Define the conditional probability distributions (CPDs) : For each variable, define it's CPD given it's parents. For example, the probability of an alarm going off depends on wheather there is burglary or an earthquake. Similarly of David & Sophia Calling depends on wheather they hear the alarm.
- Construct the Bayesian Network : Using the information gathered in steps 1-3, construct the bayesian network graphically. The graph consist of nodes representing the variables and directed edges representing the casual relationships between the variables.
- Assign initial probabilities : Assign prior probabilities to the variables. These probabilities can be obtained from domain experts or estimated from data.
- Update probabilities : Given new evidence, update the probabilities of the variables using Baye's theorem.
- Make Predictions : Use the network to make predictions about the occurence of event given the occurence or non-occurance of other variables.

```
!pip install pgmpy
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination
```

```
alarm_model = BayesianModel([('Burglary', 'Alarm'),
                              ('Earthquake', 'Alarm'),
                              ('Alarm', 'DavidCalls'),
                              ('Alarm', 'SophiaCalls')])
```

```
from pgmpy.factors.discrete import TabularCPD

cpd_burglary = TabularCPD(variable='Burglary', variable_card=2,
                      values=[[.998], [0.002]])
cpd_earthquake = TabularCPD(variable='Earthquake', variable_card=2,
                       values=[[0.999], [0.001]])
cpd_alarm = TabularCPD(variable='Alarm', variable_card=2,
                        values=[[0.94, 0.95, 0.06, 0.05],
                                [0.06, 0.05, 0.94, 0.95]],
                        evidence=['Burglary', 'Earthquake'],
                        evidence_card=[2, 2])
cpd_davidcalls  = TabularCPD(variable='DavidCalls', variable_card=2,
                      values=[[0.95, 0.1], [0.05, 0.9]],
                      evidence=['Alarm'], evidence_card=[2])
cpd_sophiacalls = TabularCPD(variable='SophiaCalls', variable_card=2
                      values=[[0.1, 0.7], [0.9, 0.3]],
                      evidence=['Alarm'], evidence_card=[2])

```

```
alarm_model.add_cpds(cpd_burglary, cpd_earthquake, cpd_alarm, cpd_davidcal
```

```
alarm_model.check_model()
```

```
True
```

```
alarm_model.nodes()
```

```
NodeView(('Burglary', 'Alarm', 'Earthquake', 'DavidCalls', 'SophiaCalls'))
```

```
alarm_model.edges()
```

```
OutEdgeView([('Burglary', 'Alarm'), ('Alarm', 'DavidCalls'), ('Alarm',
'SophiaCalls'), ('Earthquake', 'Alarm')])
```

```
alarm_model.local_independencies('Burglary')
```

```
(Burglary ⊥ Earthquake)
```

```
1 alarm_model.get_independencies()
```

```
(SophiaCalls ⊥ DavidCalls, Burglary, Earthquake | Alarm)
(SophiaCalls ⊥ Burglary, Earthquake | DavidCalls, Alarm)
(SophiaCalls ⊥ DavidCalls, Earthquake | Alarm, Burglary)
(SophiaCalls ⊥ DavidCalls, Burglary | Alarm, Earthquake)
(SophiaCalls ⊥ Earthquake | DavidCalls, Alarm, Burglary)
(SophiaCalls ⊥ Burglary | DavidCalls, Alarm, Earthquake)
(SophiaCalls ⊥ DavidCalls | Alarm, Burglary, Earthquake)
(DavidCalls ⊥ SophiaCalls, Burglary, Earthquake | Alarm)
(DavidCalls ⊥ Burglary, Earthquake | SophiaCalls, Alarm)
(DavidCalls ⊥ SophiaCalls, Earthquake | Alarm, Burglary)
(DavidCalls ⊥ SophiaCalls, Burglary | Alarm, Earthquake)
(DavidCalls ⊥ Earthquake | SophiaCalls, Alarm, Burglary)
(DavidCalls ⊥ Burglary | SophiaCalls, Alarm, Earthquake)
(DavidCalls ⊥ SophiaCalls | Alarm, Burglary, Earthquake)
(Burglary ⊥ Earthquake)
(Burglary ⊥ SophiaCalls, DavidCalls | Alarm)
(Burglary ⊥ DavidCalls | SophiaCalls, Alarm)
(Burglary ⊥ SophiaCalls | DavidCalls, Alarm)
(Burglary ⊥ SophiaCalls, DavidCalls | Alarm, Earthquake)
(Burglary ⊥ DavidCalls | SophiaCalls, Alarm, Earthquake)
(Burglary ⊥ SophiaCalls | DavidCalls, Alarm, Earthquake)
(Earthquake ⊥ Burglary)
(Earthquake ⊥ SophiaCalls, DavidCalls | Alarm)
(Earthquake ⊥ DavidCalls | SophiaCalls, Alarm)
(Earthquake ⊥ SophiaCalls | DavidCalls, Alarm)
(Earthquake ⊥ SophiaCalls, DavidCalls | Alarm, Burglary)
(Earthquake ⊥ DavidCalls | SophiaCalls, Alarm, Burglary)
(Earthquake ⊥ SophiaCalls | DavidCalls, Alarm, Burglary)
```