

## AAI EXPERIMENT NO 2 : Design And Implement Bayesian Network For Outcome Prediction In Python

```
pip install pgmpy
```

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Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from jinja2->torch->pgmpy) (3.0.3)
```

```
from pgmpy.models import DiscreteBayesianNetwork
from pgmpy.factors.discrete import TabularCPD
from pgmpy.inference import VariableElimination

# Define the network structure
model = DiscreteBayesianNetwork([
    ('Pain', 'OrthopedicDisease'),
    ('Swelling', 'OrthopedicDisease'),
    ('OrthopedicDisease', 'LossOfMovement')
])

#Define the Structure
#Suppose you have the following relationships:
# Pain and Swelling can both influence the presence of Orthopedic Disease.
#Loss of Movement can be influenced by Orthopedic Disease.

#Add Probability Tables (CPDs)
# Pain
cpd_pain = TabularCPD(variable='Pain', variable_card=2, values=[[0.7], [0.3]]) # 0: no pain, 1: pain# Swelling
cpd_swelling = TabularCPD(variable='Swelling', variable_card=2, values=[[0.8], [0.2]]) # 0: no, 1: yes# Orthopedic Disease depends on Pain and Swelling
cpd_disease = TabularCPD(
    variable='OrthopedicDisease',
    variable_card=2,
    values=[
        [0.99, 0.7, 0.8, 0.1], # No disease
        [0.01, 0.3, 0.2, 0.9] # Disease
    ],
    evidence=['Pain', 'Swelling'],
    evidence_card=[2, 2]
)

# Loss of Movement depends on Disease
cpd_loss = TabularCPD(
    variable='LossOfMovement',
    variable_card=2,
    values=[
        [0.7, 0.1], # No loss
        [0.3, 0.9] # Loss
    ],
    evidence=['OrthopedicDisease'],
    evidence_card=[2]
)

# Add CPDs to model
model.add_cpds(cpd_pain, cpd_swelling, cpd_disease, cpd_loss)
model.check_model()

True
```

```
#Make Predictions (Inference)
#Suppose a patient has pain and swelling, what's the chance they have the disease?
```

```
infer = VariableElimination(model)
result = infer.query(variables=['OrthopedicDisease'], evidence={'Pain': 1, 'Swelling': 1})
print(result)
```

```
+-----+
| OrthopedicDisease | phi(OrthopedicDisease) |
+=====+=====+
| OrthopedicDisease(0) | 0.1000 |
+-----+
| OrthopedicDisease(1) | 0.9000 |
+-----+
```

```
# -----#
```

```

"""
# Design and Implementation of Bayesian Network
# For Outcome Prediction (Pass / Fail)
# =====

# Install required package before running:
!pip install pgmpy

from pgmpy.models import DiscreteBayesianNetwork
from pgmpy.factors.discrete import TabularCPD
from pgmpy.inference import VariableElimination

# -----
# Step 1: Define Bayesian Network Structure
# -----

model = DiscreteBayesianNetwork([
    ('Attendance', 'InternalMarks'),
    ('StudyHours', 'InternalMarks'),
    ('InternalMarks', 'Result')
])

# -----
# Step 2: Define Conditional Probability Distributions (CPDs)
# -----

# Attendance Probability
cpd_attendance = TabularCPD(
    variable='Attendance',
    variable_card=2,
    values=[[0.7], [0.3]],
    state_names={'Attendance': ['High', 'Low']}
)

# Study Hours Probability
cpd_studyhours = TabularCPD(
    variable='StudyHours',
    variable_card=2,
    values=[[0.6], [0.4]],
    state_names={'StudyHours': ['Sufficient', 'Insufficient']}
)

# Internal Marks depends on Attendance and Study Hours
cpd_internalmarks = TabularCPD(
    variable='InternalMarks',
    variable_card=2,
    values=[
        [0.9, 0.6, 0.7, 0.2], # Good
        [0.1, 0.4, 0.3, 0.8] # Poor
    ],
    evidence=['Attendance', 'StudyHours'],
    evidence_card=[2, 2],
    state_names={
        'InternalMarks': ['Good', 'Poor'],
        'Attendance': ['High', 'Low'],
        'StudyHours': ['Sufficient', 'Insufficient']
    }
)

# Result depends on Internal Marks
cpd_result = TabularCPD(
    variable='Result',
    variable_card=2,
    values=[
        [0.95, 0.3], # Pass
        [0.05, 0.7] # Fail
    ],
    evidence=['InternalMarks'],
    evidence_card=[2],
    state_names={
        'Result': ['Pass', 'Fail'],
        'InternalMarks': ['Good', 'Poor']
    }
)

# -----
# Step 3: Add CPDs to the Model
# -----

model.add_cpds(
    cpd_attendance,
    cpd_studyhours,
    cpd_internalmarks,
    cpd_result
)

# -----
# Step 4: Validate the Model
# -----

print("Model is valid:", model.check_model())

# -----
# Step 5: Perform Inference (Outcome Prediction)
# -----

inference = VariableElimination(model)

# Case 1: Attendance = High, StudyHours = Sufficient
query1 = inference.query(
    variables=['Result'],
    evidence={'Attendance': 'High', 'StudyHours': 'Sufficient'}
)

```

```

print("\nPrediction when Attendance = High and StudyHours = Sufficient")
print(query1)

# Case 2: Attendance = Low, StudyHours = Insufficient
query2 = inference.query(
    variables=['Result'],
    evidence={'Attendance': 'Low', 'StudyHours': 'Insufficient'}
)

print("\nPrediction when Attendance = Low and StudyHours = Insufficient")
print(query2)

# -----
# End of Program
# -----


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Model is valid: True

Prediction when Attendance = High and StudyHours = Sufficient
+-----+-----+
| Result | phi(Result) |
+=====+=====+
| Result(Pass) | 0.8850 |
+-----+-----+
| Result(Fail) | 0.1150 |
+-----+-----+

Prediction when Attendance = Low and StudyHours = Insufficient
+-----+-----+
| Result | phi(Result) |
+=====+=====+
| Result(Pass) | 0.4300 |
+-----+-----+
| Result(Fail) | 0.5700 |
+-----+-----+

```