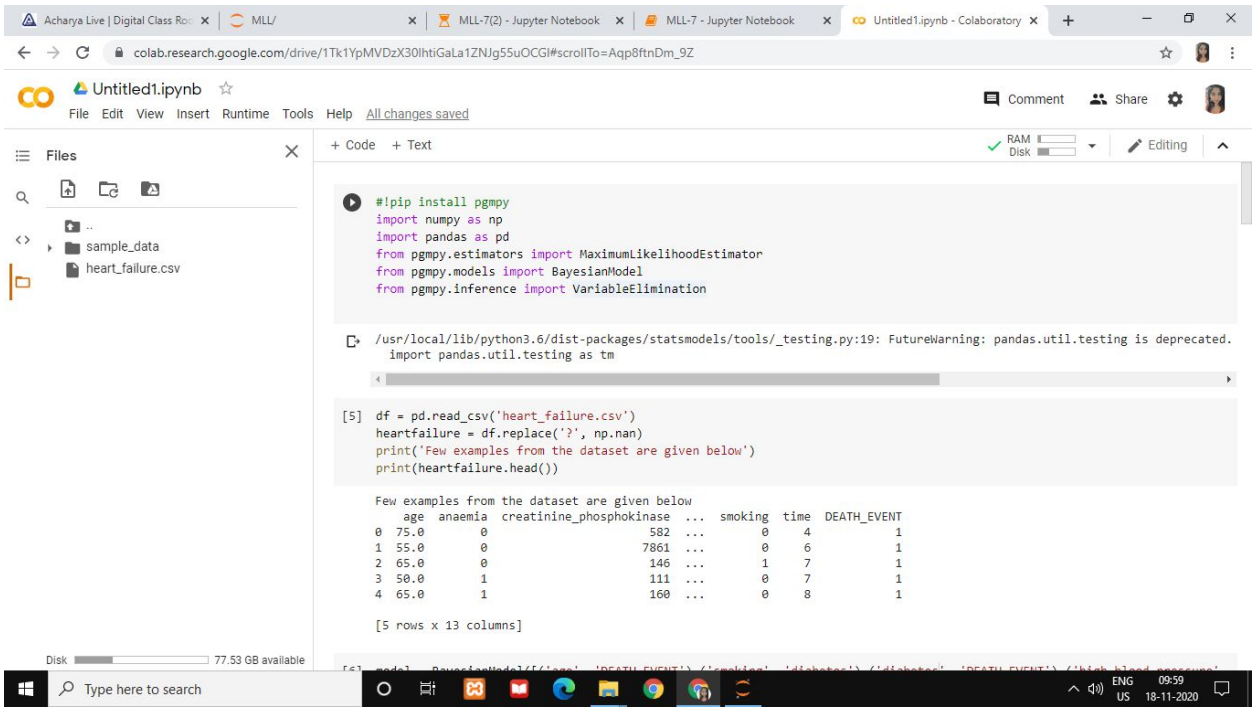
# Program-7
# Heart-failure Dataset

## Code

```
#!pip install pgmpy
import numpy as np
import pandas as pd
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination

df = pd.read_csv('heart_failure.csv')
heartfailure = df.replace('?', np.nan)
print('Few examples from the dataset are given below')
print(heartfailure.head())
model = BayesianModel([('age', 'DEATH_EVENT'),('smoking',
'diabetes'),('diabetes', 'DEATH_EVENT'),('high_blood_pressure',
'DEATH_EVENT'),('anaemia', 'platelets'),('anaemia', 'DEATH_EVENT')])


import networkx as nx
import pylab as plt
nx.draw(model, with_labels=True)
plt.show()
model.local_independencies('anaemia')
model.local_independencies('age')
model.get_independencies()

print('\nLearning CPDs using Maximum Likelihood Estimators...');
# Learing CPDs using Maximum Likelihood Estimators
model.fit(heartfailure, estimator=MaximumLikelihoodEstimator)
for cpd in model.get_cpds():
    print("CPD of {variable}:".format(variable=cpd.variable))

print(model.get_cpds('age'))

print(model.get_cpds('smoking'))

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

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

print('\n1.Probability of Heartfailure given diabetes:0')
q =
HeartFailure_infer.query(variables=['DEATH_EVENT'],evidence={'diabetes':0,
'smoking':1})
print(q)
```

## OUTPUT



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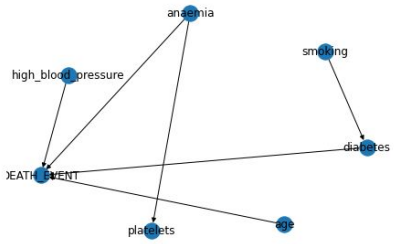
```
[6]  model = BayesianModel([('age', 'DEATH_EVENT'),('smoking', 'diabetes'),('diabetes', 'DEATH_EVENT'),('high_blood_pressure',
```

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

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sample_data
heart_failure.csv

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```
model.local_independencies('anaemia')
model.local_independencies('age')
model.get_independencies()
```

```
(anaemia _|_ high_blood_pressure | age, diabetes, smoking)
(anaemia _|_ smoking | DEATH_EVENT, platelets, high_blood_pressure, diabetes)
(anaemia _|_ smoking | DEATH_EVENT, platelets, diabetes, age)
(anaemia _|_ smoking | DEATH_EVENT, high_blood_pressure, diabetes, age)
(anaemia _|_ age | platelets, high_blood_pressure, diabetes, smoking)
(anaemia _|_ smoking | platelets, high_blood_pressure, diabetes, age)
(anaemia _|_ diabetes | platelets, age, high_blood_pressure, smoking)
(anaemia _|_ high_blood_pressure | platelets, age, diabetes, smoking)
(anaemia _|_ smoking | DEATH_EVENT, platelets, high_blood_pressure, diabetes, age)
(platelets _|_ high_blood_pressure, diabetes, smoking, age)
(platelets _|_ age, high_blood_pressure, DEATH_EVENT, diabetes, smoking | anaemia)
(platelets _|_ age, diabetes, smoking | high_blood_pressure)
(platelets _|_ age, high_blood_pressure, smoking | diabetes)
(platelets _|_ high_blood_pressure, diabetes, age | smoking)
(platelets _|_ high_blood_pressure, diabetes, smoking | age)
(platelets _|_ high_blood_pressure, diabetes, smoking, age | DEATH_EVENT, anaemia)
(platelets _|_ smoking | DEATH_EVENT, diabetes)
(platelets _|_ DEATH_EVENT, diabetes, smoking, age | high_blood_pressure, anaemia)
(platelets _|_ DEATH_EVENT, high_blood_pressure, smoking, age | diabetes, anaemia)
(platelets _|_ DEATH_EVENT, high_blood_pressure, diabetes, age | smoking, anaemia)
(platelets _|_ DEATH_EVENT, high_blood_pressure, diabetes, smoking | age, anaemia)
(platelets _|_ smoking, age | high_blood_pressure, diabetes)
(platelets _|_ diabetes, age | high_blood_pressure, smoking)
(platelets _|_ diabetes, smoking | high_blood_pressure, age)
(platelets _|_ high_blood_pressure, age | diabetes, smoking)
(platelets _|_ high_blood_pressure, smoking | diabetes, age)
```

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sample_data
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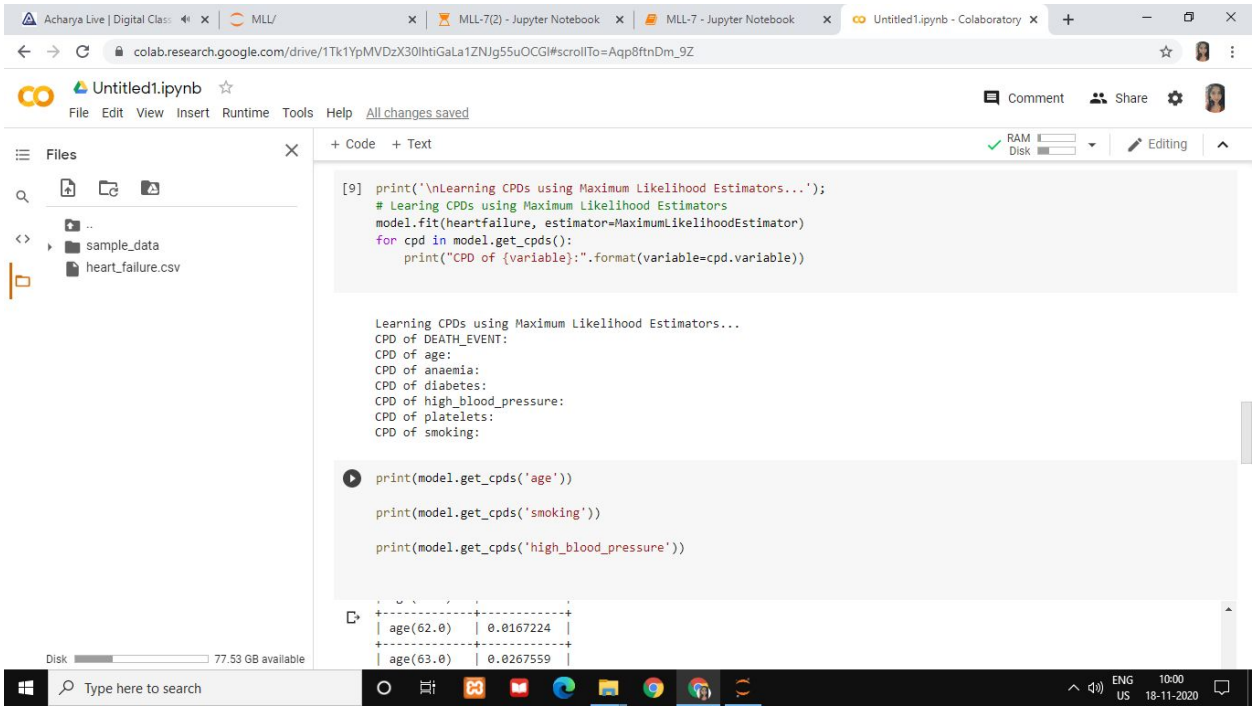
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[9] print('\nLearning CPDs using Maximum Likelihood Estimators...');
# Learing CPDs using Maximum Likelihood Estimators
model.fit(heartfailure, estimator=MaximumLikelihoodEstimator)
for cpd in model.get_cpds():
print("CPD of {variable}:".format(variable=cpd.variable))
Learning CPDs using Maximum Likelihood Estimators...
CPD of DEATH_EVENT:
CPD of age:
CPD of anaemia:
CPD of diabetes:
CPD of high_blood_pressure:
CPD of platelets:
CPD of smoking:
print(model.get_cpds('age'))
print(model.get_cpds('smoking'))
print(model.get_cpds('high_blood_pressure'))
+------------+-----------+
| age(62.0) | 0.0167224 |
+------------+-----------+
| age(63.0) | 0.0267559 |
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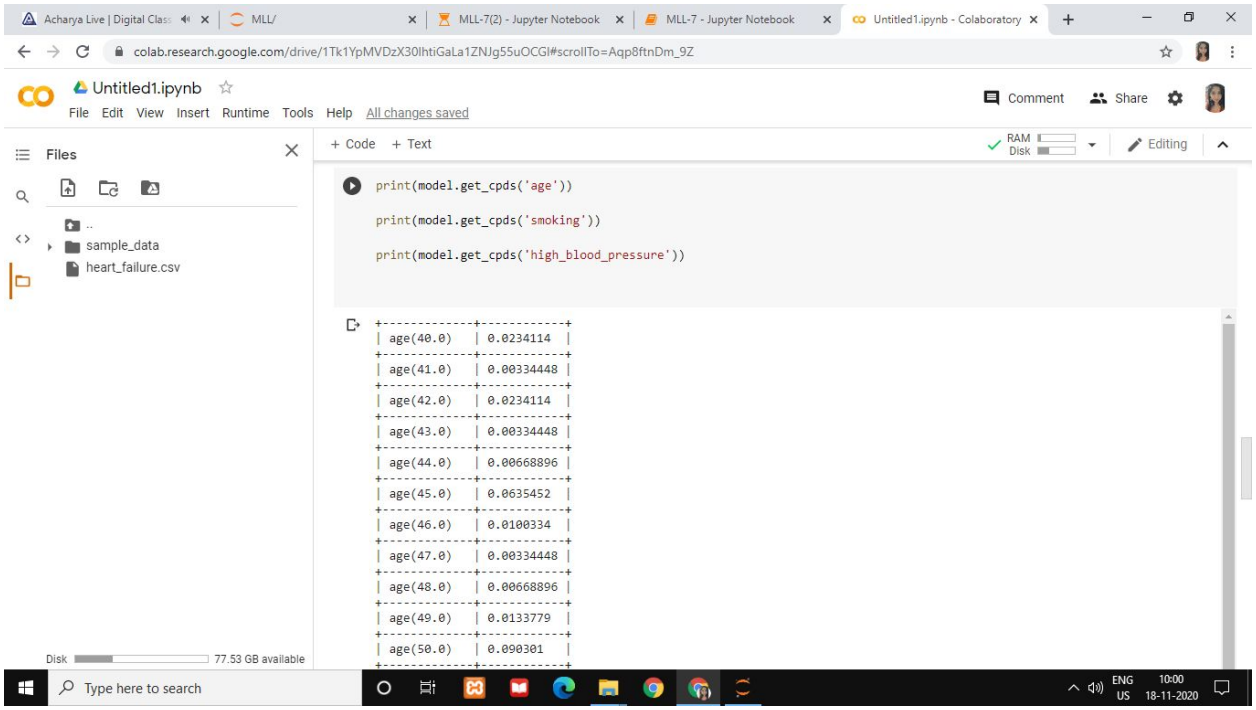
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print(model.get_cpds('age'))
print(model.get_cpds('smoking'))
print(model.get_cpds('high_blood_pressure'))
+------------+-----------+
| age(40.0) | 0.0234114 |
+------------+-----------+
| age(41.0) | 0.00334448 |
+------------+-----------+
| age(42.0) | 0.0234114 |
+------------+-----------+
| age(43.0) | 0.00334448 |
+------------+-----------+
| age(44.0) | 0.00668896 |
+------------+-----------+
| age(45.0) | 0.0635452 |
+------------+-----------+
| age(46.0) | 0.0100334 |
+------------+-----------+
| age(47.0) | 0.00334448 |
+------------+-----------+
| age(48.0) | 0.00668896 |
+------------+-----------+
| age(49.0) | 0.0133779 |
+------------+-----------+
| age(50.0) | 0.090301 |
+------------+-----------+
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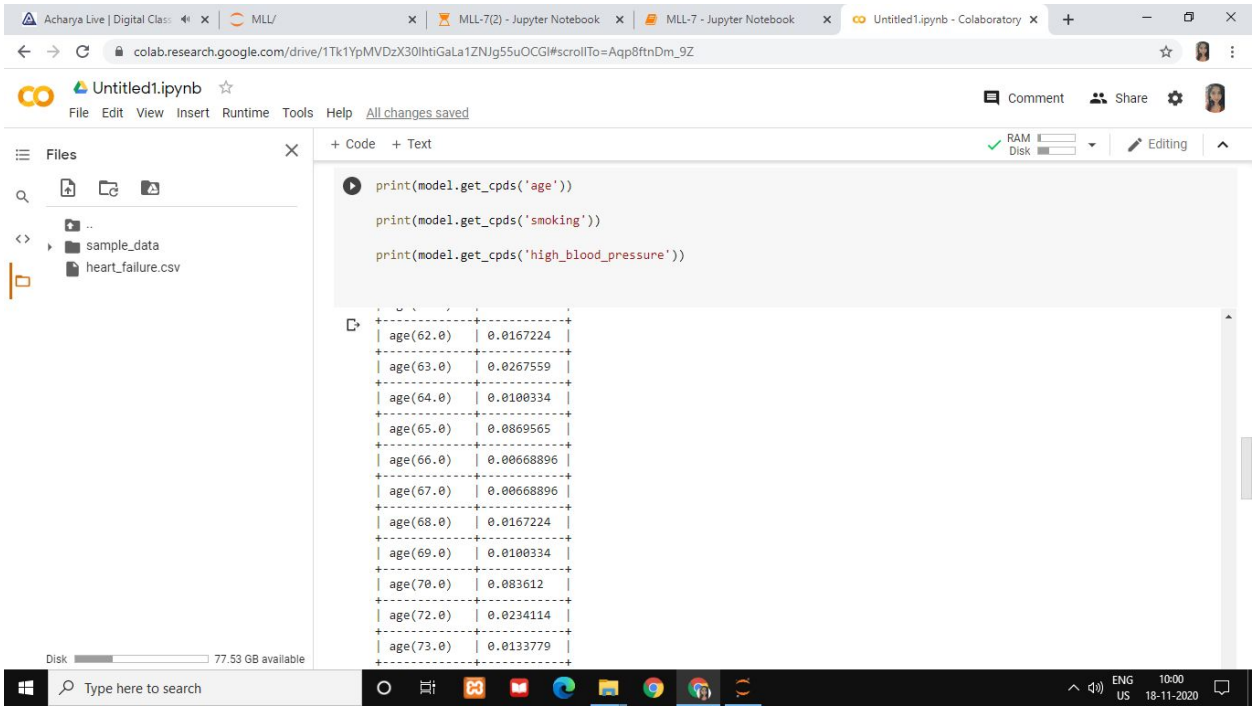
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print(model.get_cpds('age'))
print(model.get_cpds('smoking'))
print(model.get_cpds('high_blood_pressure'))
| age(62.0) | 0.0167224 |
| age(63.0) | 0.0267559 |
| age(64.0) | 0.0100334 |
| age(65.0) | 0.0869565 |
| age(66.0) | 0.00668896 |
| age(67.0) | 0.00668896 |
| age(68.0) | 0.0167224 |
| age(69.0) | 0.0100334 |
| age(70.0) | 0.083612 |
| age(72.0) | 0.0234114 |
| age(73.0) | 0.0133779 |
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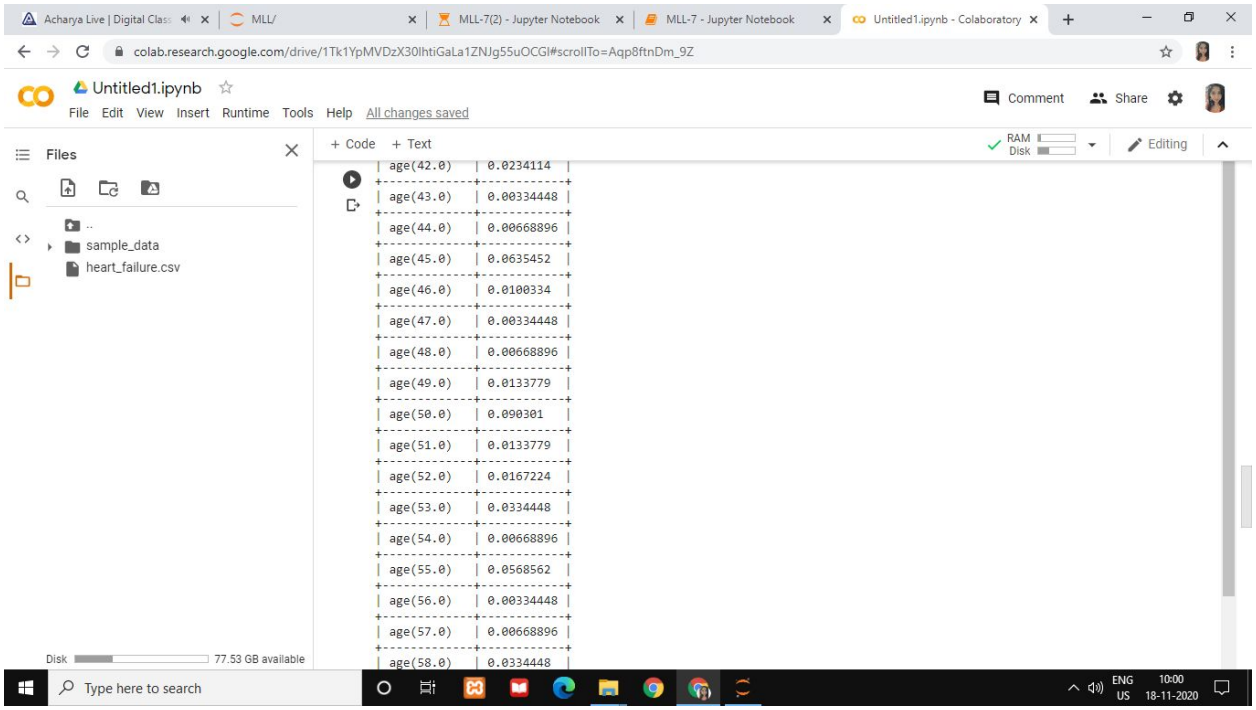
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heart_failure.csv
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| age(42.0) | 0.0234114 |
| age(43.0) | 0.00334448 |
| age(44.0) | 0.00668896 |
| age(45.0) | 0.0635452 |
| age(46.0) | 0.0100334 |
| age(47.0) | 0.00334448 |
| age(48.0) | 0.00668896 |
| age(49.0) | 0.0133779 |
| age(50.0) | 0.090301 |
| age(51.0) | 0.0133779 |
| age(52.0) | 0.0167224 |
| age(53.0) | 0.0334448 |
| age(54.0) | 0.00668896 |
| age(55.0) | 0.0568562 |
| age(56.0) | 0.00334448 |
| age(57.0) | 0.00668896 |
| age(58.0) | 0.0334448 |
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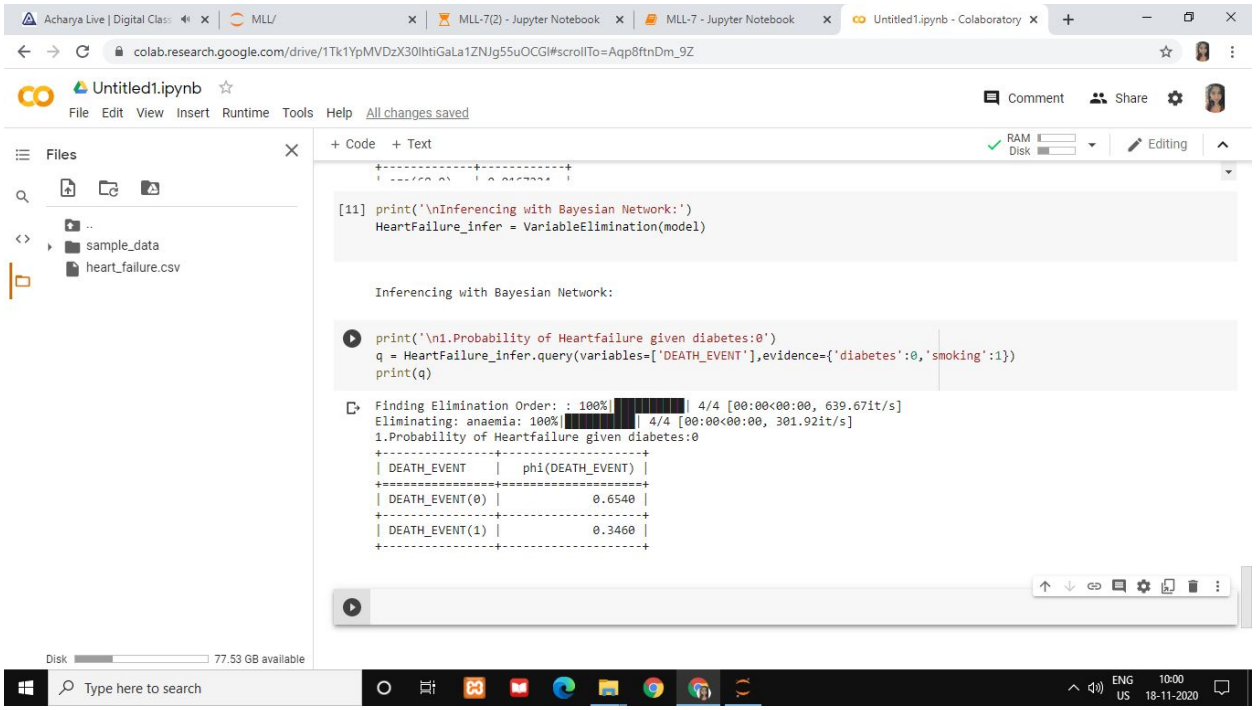
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[11] print('\nInferencing with Bayesian Network:')
HeartFailure_infer = VariableElimination(model)
Inferencing with Bayesian Network:
print('\n1.Probability of Heartfailure given diabetes:0')
q = HeartFailure_infer.query(variables=['DEATH_EVENT'],evidence={'diabetes':0,'smoking':1})
print(q)
Finding Elimination Order: : 100%| 4/4 [00:00<00:00, 639.67it/s]
Eliminating: anaemia: 100%| 4/4 [00:00<00:00, 301.92it/s]
1.Probability of Heartfailure given diabetes:0
| DEATH_EVENT | phi(DEATH_EVENT) |
| DEATH_EVENT(0) | 0.6540 |
| DEATH_EVENT(1) | 0.3460 |
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