COMP 4190 A2

Instructor: Cuneyt Akcora
Project repo: https://github.com/ZackHolmberg/4190-a2
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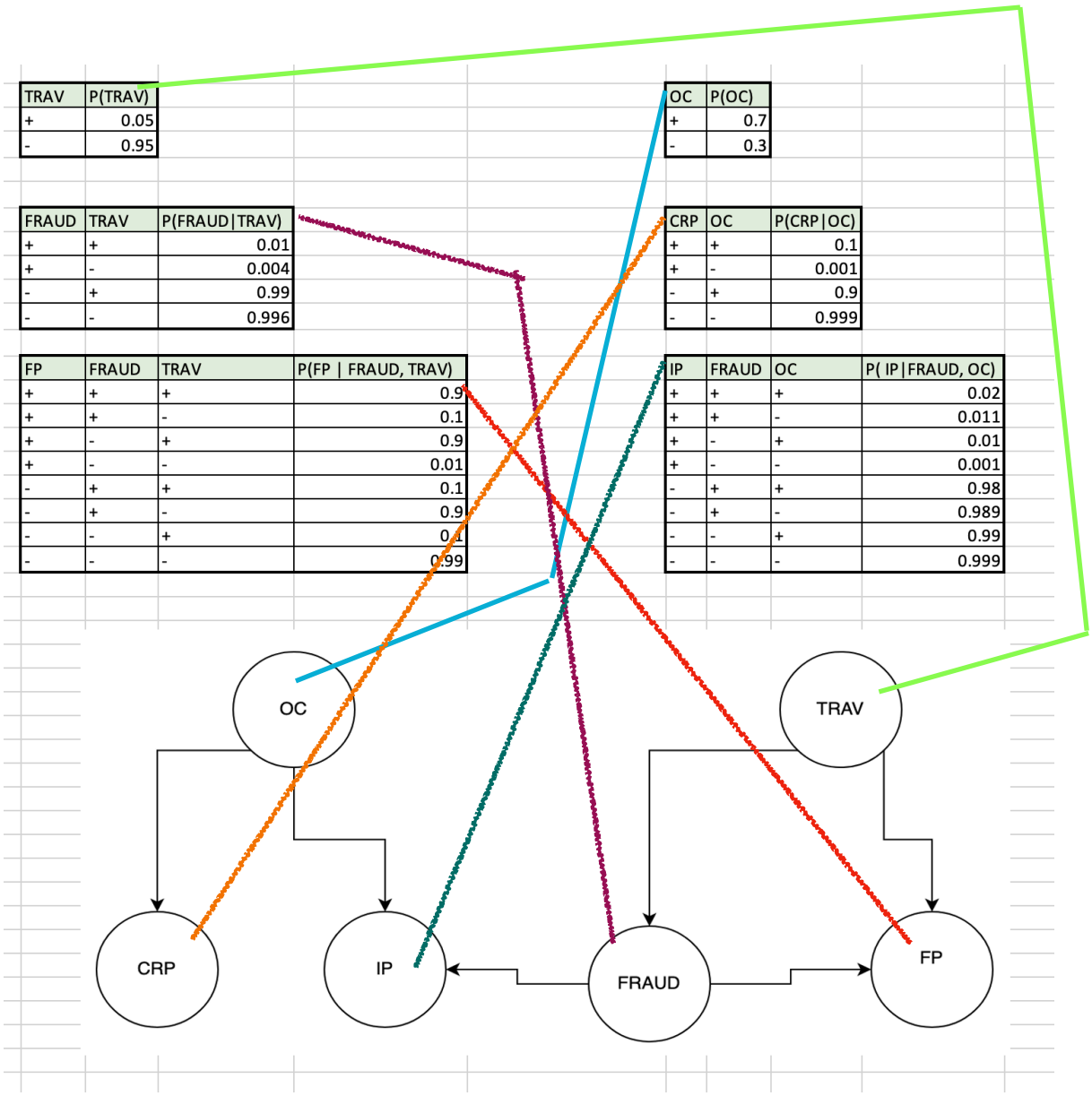
1)

Code found in assorted python files in assignment submission.

2 a)



TRAV	P(TRAV)
+	0.05
-	0.95

OC	P(OC)
+	0.7
-	0.3

FRAUD	TRAV	P(FRAUD|TRAV)
+	+	0.01
+	-	0.004
-	+	0.99
-	-	0.996

CRP	OC	P(CRP|OC)
+	+	0.1
+	-	0.001
-	+	0.9
-	-	0.999

FP	FRAUD	TRAV	P(FP | FRAUD, TRAV)
+	+	+	0.9
+	+	-	0.1
+	-	+	0.9
+	-	-	0.01
-	+	+	0.1
-	+	-	0.9
-	-	+	0.1
-	-	-	0.99

IP	FRAUD	OC	P(IP|FRAUD, OC)
+	+	+	0.02
+	+	-	0.011
+	-	+	0.01
+	-	-	0.001
-	+	+	0.98
-	+	-	0.989
-	-	+	0.99
-	-	-	0.999

2 b)

▪ *What is the prior probability (i.e., before we search for previous computer related purchases and before we verify whether it is a foreign and/or an internet purchase) that the current transaction is a fraud?*

Query used: P(FRAUD l [ ]) (No evidence)

Program output:

```
>: Leftover hidden variables to sum out: {'FP', 'IP', 'OC',
'TRAV', 'CRP'}
>: Elimination order: ['TRAV', 'FP', 'FRAUD', 'IP', 'OC', 'CRP']
>: Eliminating: TRAV
>: Joining and summing out 3 factors: ['P(TRAV), evidence=[]',
'P(FRAUD|TRAV), evidence=[]', 'P(FP|FRAUD,TRAV), evidence=[]']
>: Joining P(TRAV), evidence=[] with P(FRAUD|TRAV), evidence=[]
Table for P(TRAV,FRAUD), evidence=[]:
  -trav,-fraud  0.94620000
  -trav,+fraud  0.00380000
  +trav,-fraud  0.04950000
  +trav,+fraud  0.00050000

>: Joining P(TRAV,FRAUD), evidence=[] with P(FP|FRAUD,TRAV),
evidence=[]
Table for P(FP,TRAV,FRAUD), evidence=[]:
  -fp,-trav,-fraud  0.93673800
  -fp,-trav,+fraud  0.00342000
  -fp,+trav,-fraud  0.00495000
  -fp,+trav,+fraud  0.00005000
  +fp,-trav,-fraud  0.00946200
  +fp,-trav,+fraud  0.00038000
  +fp,+trav,-fraud  0.04455000
  +fp,+trav,+fraud  0.00045000

>: Done joining 3 factors
>: After summing out TRAV
Table for P(FP,FRAUD), evidence=[]:
  -fp,-fraud  0.94168800
  -fp,+fraud  0.00347000
  +fp,-fraud  0.05401200
  +fp,+fraud  0.00083000
```

```
>: Eliminating: FP
>: Joining and summing out 1 factors: ['P(FP,FRAUD),
evidence=[]']
>: Done joining 1 factors
>: After summing out FP
Table for P(FRAUD), evidence=[]:
  -fraud  0.99570000
  +fraud  0.00430000

>: Eliminating: IP
>: Joining and summing out 1 factors: ['P(IP|FRAUD,OC),
evidence=[]']
>: Done joining 1 factors
>: Omitting this unused factor: P(IP|FRAUD,OC), evidence=[]
>: Eliminating: OC
>: Joining and summing out 2 factors: ['P(OC), evidence=[]',
'P(CRP|OC), evidence=[]']
>: Joining P(OC), evidence=[] with P(CRP|OC), evidence=[]
Table for P(OC,CRP), evidence=[]:
  -oc,-crp  0.29970000
  -oc,+crp  0.00030000
  +oc,-crp  0.63000000
  +oc,+crp  0.07000000

>: Done joining 2 factors
>: After summing out OC
Table for P(CRP), evidence=[]:
  -crp  0.92970000
  +crp  0.07030000

>: Eliminating: CRP
>: Joining and summing out 1 factors: ['P(CRP), evidence=[]']
>: Done joining 1 factors
>: Omitting this unused factor: P(CRP), evidence=[]
>: Final join of remaining factor
Table for P(FRAUD), evidence=[]:
  -fraud  0.99570000
  +fraud  0.00430000

>: Normalized factor
Table for P(FRAUD), evidence=[]:
  -fraud  0.99570000
  +fraud  0.00430000
```

```
>: Inference result
Table for P(FRAUD), evidence=[]:
  -fraud  0.99570000
  +fraud  0.00430000
```

- *What is the probability that the current transaction is a fraud once we have verified that it is a foreign transaction, but not an internet purchase and that the card holder purchased computer related accessories in the past week?*

Query used: P(FRAUD | +FP, -IP, +CRP)

Program output:

```
>: Leftover hidden variables to sum out: {'TRAV', 'OC'}
>: Elimination order: ['TRAV', 'FP', 'FRAUD', 'IP', 'OC', 'CRP']
>: Eliminating: TRAV
>: Joining and summing out 3 factors: ["P(TRAV),
evidence=['+crp', '-ip', '+fp']", "P(FRAUD|TRAV),
evidence=['+crp', '-ip', '+fp']", "P(FP|FRAUD,TRAV),
evidence=['+crp', '-ip', '+fp']"]
>: Joining P(TRAV), evidence=['+crp', '-ip', '+fp'] with
P(FRAUD|TRAV), evidence=['+crp', '-ip', '+fp']
Table for P(TRAV,FRAUD), evidence=['+fp', '+crp', '-ip']:
  -trav,-fraud  0.94620000
  -trav,+fraud  0.00380000
  +trav,-fraud  0.04950000
  +trav,+fraud  0.00050000

>: Joining P(TRAV,FRAUD), evidence=['+fp', '+crp', '-ip'] with
P(FP|FRAUD,TRAV), evidence=['+crp', '-ip', '+fp']
Table for P(TRAV,FP,FRAUD), evidence=['+fp', '+crp', '-ip']:
  -trav,+fp,-fraud  0.00946200
  -trav,+fp,+fraud  0.00038000
  +trav,+fp,-fraud  0.04455000
  +trav,+fp,+fraud  0.00045000

>: Done joining 3 factors
>: After summing out TRAV
Table for P(FP,FRAUD), evidence=['+fp', '+crp', '-ip']:
  +fp,-fraud  0.05401200
```

```
  +fp,+fraud  0.00083000

>: Eliminating: OC
>: Joining and summing out 3 factors: ["P(OC), evidence=['+crp',
'-ip', '+fp']", "P(CRP|OC), evidence=['+crp', '-ip', '+fp']",
"P(IP|FRAUD,OC), evidence=['+crp', '-ip', '+fp']"]
>: Joining P(OC), evidence=['+crp', '-ip', '+fp'] with P(CRP|
OC), evidence=['+crp', '-ip', '+fp']
Table for P(CRP,OC), evidence=['+fp', '+crp', '-ip']:
  +crp,-oc  0.00030000
  +crp,+oc  0.07000000

>: Joining P(CRP,OC), evidence=['+fp', '+crp', '-ip'] with P(IP|
FRAUD,OC), evidence=['+crp', '-ip', '+fp']
Table for P(CRP,IP,OC|FRAUD), evidence=['+fp', '+crp', '-ip']:
  -fraud,+crp,-ip,-oc  0.00029970
  -fraud,+crp,-ip,+oc  0.06930000
  +fraud,+crp,-ip,-oc  0.00029670
  +fraud,+crp,-ip,+oc  0.06860000

>: Done joining 3 factors
>: After summing out OC
Table for P(CRP,IP|FRAUD), evidence=['+fp', '+crp', '-ip']:
  -fraud,+crp,-ip  0.06959970
  +fraud,+crp,-ip  0.06889670

>: Final joint factor
Table for P(CRP,FRAUD,IP,FP), evidence=['+fp', '+crp', '-ip']:
  +crp,-fraud,-ip,+fp  0.00375922
  +crp,+fraud,-ip,+fp  0.00005718

>: Normalized factor
Table for P(CRP,FRAUD,IP,FP), evidence=['+fp', '+crp', '-ip']:
  +crp,-fraud,-ip,+fp  0.98501619
  +crp,+fraud,-ip,+fp  0.01498381


>: Inference result
Table for P(FRAUD|CRP,IP,FP), evidence=['+fp', '+crp', '-ip']:
  +crp,-ip,+fp,-fraud  0.98501619
  +crp,-ip,+fp,+fraud  0.01498381
```