**CS486 - Homework Assignment 2 Chen Lang 20528863**

2 (a)

**Pr(Trav)**

|  |  |
| --- | --- |
| **Trav** |  |
| True | 0.05 |
| False | 0.95 |

**Pr(OC)**

|  |  |
| --- | --- |
| **OC** |  |
| True | 0.8 |
| False | 0.2 |

**Pr(IP | Fraud, OC)**

|  |  |  |  |
| --- | --- | --- | --- |
| **IP** | **Fraud** | **OC** |  |
| True | True | True | 0.15 |
| True | True | False | 0.051 |
| True | False | True | 0.1 |
| True | False | False | 0.001 |
| False | True | True | 0.85 |
| False | True | False | 0.949 |
| False | False | True | 0.9 |
| False | False | False | 0.999 |

**Pr(CRP | OC)**

|  |  |  |
| --- | --- | --- |
| **CRP** | **OC** |  |
| True | True | 0.1 |
| True | False | 0.01 |
| False | True | 0.9 |
| False | False | 0.99 |

**Pr(FP | Fraud, Trav)**

|  |  |  |  |
| --- | --- | --- | --- |
| **FP** | **Fraud** | **Trav** |  |
| True | True | True | 0.9 |
| True | True | False | 0.1 |
| True | False | True | 0.9 |
| True | False | False | 0.01 |
| False | True | True | 0.1 |
| False | True | False | 0.9 |
| False | False | True | 0.1 |
| False | False | False | 0.99 |

**Pr(Fraud | Trav)**

|  |  |  |
| --- | --- | --- |
| **Fraud** | **Trav** |  |
| True | True | 0.01 |
| True | False | 0.004 |
| False | True | 0.99 |
| False | False | 0.996 |

2 (b) (1)

**Elimination procedure:**

|  |  |  |
| --- | --- | --- |
| **Fraud** | **Trav** |  |
| True | True | 0.0005 |
| True | False | 0.0038 |
| False | True | 0.0495 |
| False | False | 0.9462 |

Sumout **Trav** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.0043 |
| False | 0.9957 |

(b) (2)

**Elimination procedure:**

to

|  |  |  |
| --- | --- | --- |
| **Fraud** | **Trav** |  |
| True | True | 0.9 |
| True | False | 0.1 |
| False | True | 0.9 |
| False | False | 0.01 |

to

|  |  |  |
| --- | --- | --- |
| **Fraud** | **OC** |  |
| True | True | 0.85 |
| True | False | 0.949 |
| False | True | 0.9 |
| False | False | 0.999 |

to

|  |  |
| --- | --- |
| **OC** |  |
| True | 0.1 |
| False | 0.01 |

|  |  |  |
| --- | --- | --- |
| **Fraud** | **Trav** |  |
| True | True | 0.00045 |
| True | False | 0.00038 |
| False | True | 0.04455 |
| False | False | 0.009462 |

Sumout **Trav** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.00083 |
| False | 0.054012 |

|  |  |  |
| --- | --- | --- |
| **Fraud** | **OC** |  |
| True | True | 0.068 |
| True | False | 0.001898 |
| False | True | 0.072 |
| False | False | 0.001998 |

Sumout **OC** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.069898 |
| False | 0.073998 |

After normalizing:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.9857 |

Multiply the rest factors:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.004 |

2 (c)

**Elimination procedure:**

to

|  |  |  |
| --- | --- | --- |
| **Fraud** | **Trav** |  |
| True | True | 0.9 |
| True | False | 0.1 |
| False | True | 0.9 |
| False | False | 0.01 |

to

|  |  |  |
| --- | --- | --- |
| **Fraud** | **OC** |  |
| True | True | 0.85 |
| True | False | 0.949 |
| False | True | 0.9 |
| False | False | 0.999 |

to

|  |  |
| --- | --- |
| **OC** |  |
| True | 0.1 |
| False | 0.01 |

to

|  |  |
| --- | --- |
| **Trav** |  |
| True | 0.05 |

to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.01 |
| False | 0.99 |

to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.9 |
| False | 0.9 |

|  |  |  |
| --- | --- | --- |
| **Fraud** | **OC** |  |
| True | True | 0.068 |
| True | False | 0.001898 |
| False | True | 0.072 |
| False | False | 0.001998 |

Sumout **OC** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.069898 |
| False | 0.073998 |

After normalizing:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.99055 |

Multiply the rest factors:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.0033 |

2 (d)

The action taken is making an unimportant purchase over internet first, which makes CRP = true.

Doing so, the system will generate:

to

|  |  |  |
| --- | --- | --- |
| **Fraud** | **OC** |  |
| True | True | 0.15 |
| True | False | 0.051 |
| False | True | 0.1 |
| False | False | 0.001 |

|  |  |  |  |
| --- | --- | --- | --- |
| **FP** | **Fraud** | **Trav** |  |
| True | True | True | 0.00045 |
| True | True | False | 0.00038 |
| True | False | True | 0.04455 |
| True | False | False | 0.009462 |
| False | True | True |  |
| False | True | False | 0.00342 |
| False | False | True | 0.00495 |
| False | False | False | 0.936738 |

Sumout **Trav** in to

|  |  |  |
| --- | --- | --- |
| **FP** | **Fraud** |  |
| True | True | 0.00083 |
| True | False | 0.054012 |
| False | True | 0.00347 |
| False | False | 0.941688 |

|  |  |  |
| --- | --- | --- |
| **FP** | **Fraud** |  |
| True | True | 0.00083 |
| True | False | 0.054012 |
| False | True | 0.00347 |
| False | False | 0.941688 |

Sumout **FP** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.0043 |
| False | 0.9957 |

|  |  |  |  |
| --- | --- | --- | --- |
| **CRP** | **Fraud** | **OC** |  |
| True | True | True | 0.012 |
| True | True | False | 0.000102 |
| True | False | True | 0.008 |
| True | False | False |  |
| False | True | True | 0.108 |
| False | True | False | 0.010098 |
| False | False | True | 0.072 |
| False | False | False | 0.000198 |

Sumout **OC** in to

|  |  |  |
| --- | --- | --- |
| **CRP** | **Fraud** |  |
| True | True | 0.012102 |
| True | False | 0.008002 |
| False | True | 0.118098 |
| False | False | 0.072198 |

|  |  |  |
| --- | --- | --- |
| **CRP** | **Fraud** |  |
| True | True | 0.012102 |
| True | False | 0.008002 |
| False | True | 0.118098 |
| False | False | 0.072198 |

Sumout **CRP** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.1302 |
| False | 0.0802 |

After normalizing:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.99303786607 |

Multiply the rest factors:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.07986 |

After that, the system will generate:

to

|  |  |  |
| --- | --- | --- |
| **Fraud** | **OC** |  |
| True | True | 0.15 |
| True | False | 0.051 |
| False | True | 0.1 |
| False | False | 0.001 |

to

|  |  |
| --- | --- |
| **OC** |  |
| True | 0.1 |
| False | 0.01 |

|  |  |  |  |
| --- | --- | --- | --- |
| **FP** | **Fraud** | **Trav** |  |
| True | True | True | 0.00045 |
| True | True | False | 0.00038 |
| True | False | True | 0.04455 |
| True | False | False | 0.009462 |
| False | True | True |  |
| False | True | False | 0.00342 |
| False | False | True | 0.00495 |
| False | False | False | 0.936738 |

Sumout **Trav** in to

|  |  |  |
| --- | --- | --- |
| **FP** | **Fraud** |  |
| True | True | 0.00083 |
| True | False | 0.054012 |
| False | True | 0.00347 |
| False | False | 0.941688 |

|  |  |  |
| --- | --- | --- |
| **FP** | **Fraud** |  |
| True | True | 0.00083 |
| True | False | 0.054012 |
| False | True | 0.00347 |
| False | False | 0.941688 |

Sumout **FP** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.0043 |
| False | 0.9957 |

|  |  |  |
| --- | --- | --- |
| **CRP** | **Fraud** |  |
| True | True | 0.012 |
| True | False | 0.000102 |
| False | True | 0.008 |
| False | False |  |

Sumout **FP** in to

|  |  |
| --- | --- |
| **Fraud** |  |
| True | 0.012102 |
| False | 0.008002 |

Multiply the rest factors:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.079676 |

After normalizing:

|  |  |
| --- | --- |
| **Fraud** |  |
| True |  |
| False | 0.99351109715 |

Above all,

The probability of a fraud gets reduced is

3 (a)

1. No, D and G are dependent. There is a path from D to G which is not blocked since there is no evidence in that path. So, D and G are dependent.
2. No, D and G are dependent. There is an evidence F in one path from D to G, but there is another path from D to G that is not blocked. So, D and G are dependent.
3. Yes, A and G are independent. The indirect path from A to A and other indirect paths from G to C enter B, but there is no evidence for B, and B does not have descendent. So, B blocks all paths between A and G, and they are d-separated. So, A and G are independent.
4. No, A and G are dependent. The indirect path from G to D goes into C, and the indirect path from A to B goes out C. C is not in the evidence set, so this path between A and G is not blocked. So, A and G are dependent.
5. Yes, A and G are independent. Firstly, the indirect path from A to B leaves C, and indirect path from G to D enters C. Also, there is an evidence for C. So, this path is blocked. Secondly, the indirect path from A to B and the indirect path from G to E both leave C, and there is an evidence for C. So, this path is also blocked. Thus, paths between A and G are blocked, and they are d-separated. So, A and G are independent.
6. Yes, A and G are independent. Firstly, the indirect path from A to C and the indirect path from G to F both leave D, and there is an evidence for D. So, this path is blocked. Secondly, the indirect path from A to C and the indirect path from G to F both enter E, and there is no evidence for E. So, this path is also blocked. Thus, paths between A and G are blocked, and they are d-separated. So, A and G are independent.
7. No, A and G are dependent. The indirect path from G to F and the indirect path from A to C both enter E. E is in the evidence set, so this path between A and G is not blocked. So, A and G are dependent.

3 (b)

1. C is relevant since C is the query variable.
2. D is relevant since D is the parent of C, and C is relevant.
3. E is relevant since E is in evidence set, and E is the descendent of a relevant node C.
4. F is relevant since F is the parent of E, and F is relevant.

Above all, the subset of relevant variables that is sufficient to answer this query is {C, D, E, F}.